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ABSTRACT

Contents of this double journal issue concern immunization and primary health care of children. The issue decribes vaccine storage and sterilization techniques, giving particular emphasis to the role of the cold chain, i.e., the maintenance of a specific temperature range to assure potency of vaccines as they are moved from a national storage center to regional storage centers, peripheral immunization centers, clinics, and mobile teams. The first section of the issue discusses immunization and primary health care, vaccines, organization of vaccination, community participation, training of personnel, evaluation of immunization programs, and accelerating the implementation of immunization programs. The section on storage and sterilization techniques focuses on reasons for the cold chain, management of vaccine supplies, needed facilities and their use, monitoring the cold chain, and training persons responsible for maintaining the cold chain. An appendix briefly discusses the activities of a resarch unit known as the GRET/GERES (Groupe de Recherches et d'Echanges Technologiques/Groupe Energies Renouvelables) renewable energies unit, which is concerned with the use of renewable energies and the reduction of the technical and economic burden of energy on health organizations. (RH)

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1986 N 162/163 IMMUNIZATION

in the TROPICS

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The International Children's Centre was created by the French government in 1949, on the initiative of Professor Robert Debré in particular, following negotiations between France and the United Nations. Its purpose was to furnish those international and national agencies dealing specifically with child care with training facilities and educational and informational tools in the field of child health and development, viewing children within their family and surroundings.

ICC soon turned essentially toward Third World children and devoted its activities to the training and education of personnel with social, educational and administrative responsibilities as well as medical and paramedical workers. The desire for greater efficiency has led it to work increasingly with trainers and to concentrate its efforts on the methodological and educational aspects of mother and child care programmes.

ICC is also engaged in an attempt to further study — and — action on some aspects of the life and health of children and their family, so as to contribute to practical improvement, particularly in the fields of growth, nutrition, planned parenthood, the control of transmissible and nutritional diseases, preschool and school education, the needs of disabled and underprivileged children, etc.

Over this period of more than 30 years, a large amount of documents on children and adolescents, mostly from the developing countries, has been accumulated. This international documentation has been classified and sorted out, and has been computerized since 1983 : a bibliographic data base (BIRD : "Base d'Informations Robert Debré") may be consulted anywhere in the world, through international communications networks. ICC also publishes periodicals, educational documents and specialized bibliographic bulletins.

As for its legal status, the International Children's Centre is a foundation under french law of recognized public utility, administered by an executive board with broad international membership.

1986 - N° 162/163

CHILDREN IN THE TROPICS

SIX ISSUES PER YEAR

edited by

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Translated from French to English by Helen ARNOLD.

I. IMMUNIZATION

1. IMMUNIZATION AND PRIMARY HEALTH CARE

1.1. Introduction

Children constitute the majority of the population in the developing countries. Often they are said to be the most precious of all treasures, and yet they suffer the consequences of poverty and poor living conditions in many areas. Each day, nearly 40,000 children die of malnutrition or infection; these are the main health problems in the developing countries.

The World Health Organization (WHO) estimates that 4 million children died before their first birthday in 1984, while another 4 million were affected with a physical or mental disability caused by one of the following six infectious diseases: tuberculosis, diphtheria, tetanus, pertussis, poliomyelitis and measles. In other words, each time you draw your breath, a child is dying of a disease which might easily have been avoided by immunization.

It was in response to this situation that WHO set up a special programme, the Expanded Programme on Immunization (EPI), in 1974. The EPI was actually launched in 1977; its objective is to have immunized all of the world's children, and particularly those under one year old, against these six diseases by 1990.

1.2. The EPI yesterday and today

The first great universal victory in the field of immunization was the eradication of smallpox in 1977. This victory was achieved after many years of a relentless battle, centralized by WHO. This organization made use of a great many teams and ran its own programmes, often independantly of the national health services of the different countries.

Since 1977, WHO, FISE/UNICEF (the United Nations Children's Fund) and various governmental and non-governmental agencies have committed themselves to participate in the EPI, in a rather unusual way. This is a permanent programme: each year, a cohort of children is born and must be vaccinated at the proper time. The aim of the programme is not to eradicate all diseases, but only some of them, and to decrease the incidence of the others.

An effort is made to reinforce the basic health structures, so that they may distribute the vaccines: this is essential for the evaluation of such a permanent, ongoing programme. The

success of the immunization policy depends above all on the possibilities of developing the health structures, and the means of providing access to immunization for all of a country's children.

The EPI is one part of primary health care. As such, it is integrated in the services provided at the most peripheral level. It is implemented along with:

— diarrhoea control and simple treatment of the most common ailments;
— the encouragement of breast-feeding and of appropriate, balanced nutrition;
— the fight against infections and those endemic diseases present in the community;
— the furnishing of essential drugs;
— the enhancement of maternal and child health, including planned parenthood;
— improving sanitation and the supply of clean drinking water;
— education and information for health.

In recent years the EPI has progressed, thanks to the efforts made by many countries and the help they received in procuring vaccines, training personnel, planning and implementing programmes, reinforcing primary health care and mother and child care structures, establishing an epidemiological surveillance system, and ensuring the supervision and regular evaluation of their programmes.

Financial aid is used to purchase vaccines, equipment and vehicles, as well as for training and supervision. A tremendous effort is now being made, by UNICEF in particular, to mobilize social and political forces in favour of immunization.

Many countries have shown interest in the EPI, and set up their own programme. The number of children vaccinated during the first year of life is constantly increasing. According to WHO estimates, the lives of one million children were saved by immunization in 1985. Much work still remains to be done, however: only 35 to 40% of all children under one year old have been immunized against all six diseases. We are still far from our objective.

As a result, national vaccination days have been organized, and such actions are only one aspect of the strategy aimed at having all children immunized by 1990. They will only be effective if these days are preceded, accompanied and followed by the approaches discussed below.

2. VACCINES

2.1. What is a vaccine?

The human body is capable of producing certain substances, known as antibodies, which fight off the germs that cause infectious diseases. When someone catches measles, for instance, his/her body produces the antibodies which will provide protection agains another bout of the disease, and which last a lifetime.

There are two ways of inducing the formation of antibodies in the human body. The first is through contact with the germ responsible for the disease, and which of course leads to the formation of defense mechanisms. The price is clinical disease, possibly severe, often

with complications and sometimes fatal. The second way of inducing the production of antibodies by the organism is to place it in contact with a germ which has been attenuated or killed in a laboratory, and which is called a vaccine. In this case antibodies will be produced in the absence of any severe disease, and with few clinical signs.

A vaccine, then, is composed of one or several attenuated or killed germs, or of a purified chemical substance which stimulates the production of antibodies, and consequently protects the person who has received it against those diseases before he or she catches them.

2.2. Why immunize?

Immunization is a typical example of a public health measure. It has many qualities.

It is an essential measure, which may avoid the death of a great many children. It protects against diseases for which no highly effective treatment exists, such as poliomyelitis or tetanus. It improves the quality of the lives of many children, by avoiding the physical disabilities produced by some diseases. Furthermore, it helps interrupt the contribution of certain diseases to the vicious circle of malnutrition and disease.

As far as effectiveness is concerned, immunization is a universally recognized means of avoiding disease. We will present the results, in terms of the reduction of the number of cases of disease, to be expected for each vaccine. Furthermore, immunization is a perfectly reliable means of prevention. It induces very few complications: far fewer, in any case, than the disease itself.

Financially speaking, immunization is much less expensive: it costs far less to vaccinate everyone than to treat disease in some people. It is more economical than most other medical or non-medical preventive measures.

Community participation may be called upon for the implementation of immunization. It does not require any basic changes in people's habits, way of life or social organization. Technically speaking, vaccination has become relatively easy. Modern technology has led to the preparation of more stable, highly effective vaccines, easier to administer and to use in association. The international political will and mobilization around the immunization of children have provided concerned-governments with the necessary logistic, technical and financial means.

Although immunization by itself, is an excellent measure, it cannot solve all problems. The fight against malaria, malnutrition and diarrhoea are also high-ranking health priorities. In order to deal with them we must not only improve health services, but sanitation services as well, and improve the orientation of food, social work and mother and child care policies.

2.3. The vaccines in the EPI

The objective of WHO's EPI is to make immunization available for all of the world's children in 1990. Special emphasis is placed on children under one year old and on six diseases which take a particularly heavy toll on small children: measles, pertussis, tetanus, tuberculosis, poliomyelitis and diphtheria. We will discuss the vaccines in the chronological order of their administration.

2.3.1. The BCG vaccine

The BCG provides protection against childhood tuberculosis.

- Composition

The BCG is a live vaccine made of attenuated bacilli, the Bacilli of Calmette and Guérin, whence it's name, BCG.

- Preparation and packaging

It is freeze-dried; that is, in powder form, and must be dissolved in a diluent before administration.

The vials contain variable quantities, prepared to obtain 10, 20 or 50 doses of vaccine once the diluent has been added. The amount of diluent to be added is 1, 2 or 5 cc, respectively. Once the vaccine has been dissolved, the solution represents 10, 20 or 50 0.1 cc doses, containing 1 mg/cc of dried vaccine.

Some vials are brown coloured, so as to protect the vaccine from light. Others are transparent, but are delivered with a black paper cap, to be placed around the vial during its use.

- Storage

The freeze-dried (lybphilized) BCG vaccine may be stored either in a freezer at − 20 °C, or in a refrigerator (between 0 and + 8 °C), for several months.

The diluent should be kept in a refrigerator. If there is not enough room in the refrigerator, it may be kept at room temperature, in a cupboard but must be placed in a refrigerator 48 hours before use. It is best to replace the cold vial just taken from the refrigerator with another one, for use two days later.

Once reconstituted, the vaccine must be stored in a cold place, in bottles or on a cold pack and used within the hour. The live particles of reconstituted BCG die rapidly, and half of the bacilli are already dead at the end of one hour.

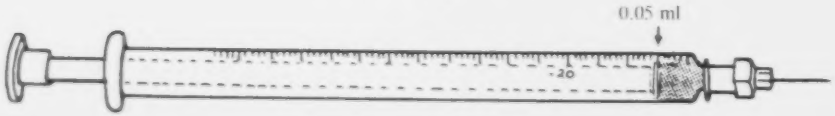
- Vaccination

It is performed intradermally, generally on the median part of the posterior side of the left arm. In some countries it is performed on the anterior side of the forearm.

The dose administered is 0.05 cc for children under one year old and 0.1 cc for children over one.

Figure 1

The course of BCG vaccine



Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/1.

Approximately 0.5 cc of vaccine is drawn into the special BCG syringe (1 cc OMEGA syringe, graduated to 1/100) using the intradermic needle. The syringe is held vertically and tapped lightly (see fig. 2), to detach the air bubbles adhering to the sides. The piston is then pushed in, to eliminate the air, until a drop of vaccine comes to the tip of the needle.

Figure 2

Tapping OMEGA syringe to expel air bubbles

Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/3.

The child should be held firmly. The skin is cleansed (when possible) and the tip of the needle is inserted into the superficial layer of the skin. 0.05 cc of vaccine is injected gently, and the needle is withdrawn. When properly performed, an intradermal injection produces a papule (a pimple), somewhat crackled in appearance, like an "orange skin".

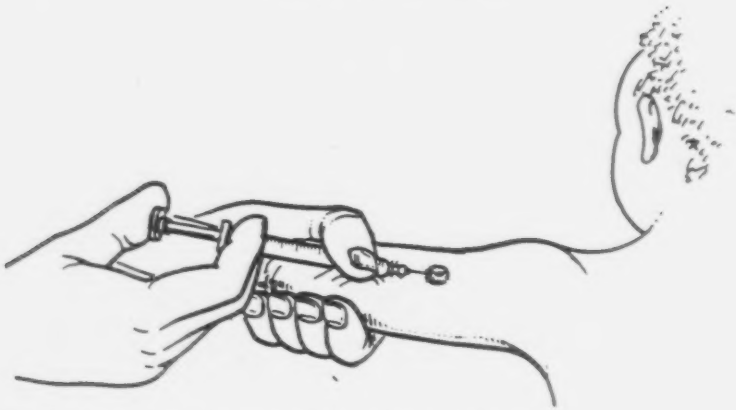
The piston is hard to push. If it can be pushed in easily, then the needle is inserted too deeply. It must be removed, its position corrected and the rest of the dose administered.

Once the needle has been withdrawn:

— either it is placed with the used needles, and another one is taken for the next injection of BCG;

Figure 3

Giving BCG vaccine - position

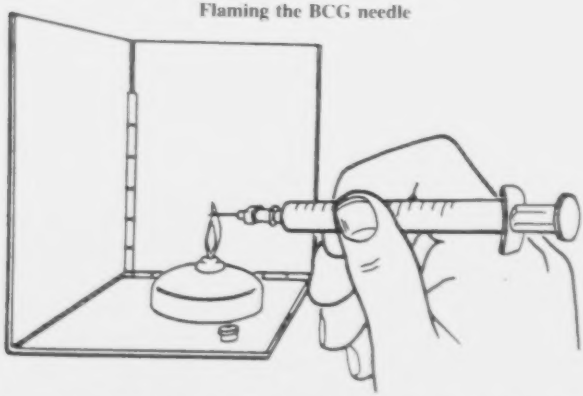


Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/3.

— or the tip of the needle is passed through the flame of an alcohol-burning lamp (Fig. 4), until it turns red. Several drops of vaccine are then pushed through it (to cool the needle, and to eliminate the part of the vaccine which was damaged by the heat), by pressing on the piston. The UNICEF "BCG kit" contains this type of material (flame-resistant needles, wind-breaker and alcohol-burning lamp).

Figure 4

Flaming the BCG needle



Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/3.

- Who should be vaccinated?

Children born in a maternity ward are vaccinated before their discharge, and the others are vaccinated when they are seen.

- Reactions to vaccination

Normally, a small, hard ball develops at the injection site 2 to 4 weeks later. It may disappear or turn red, become a small abscess, suppurate, then dry up and leave a scar.

Mothers should be warned of these reactions, and should not do anything special, outside of the usual cleansing of the skin, and protecting the sore with a dry dressing. Occasionaly the abscess may be deep and the purulence long-lasting, or a gland will swell in the armpit. Parents should be reassured: this is never a serious matter. If the gland becomes soft, the child should be taken to see a doctor, who will decide what is to be done.

2.3.2. The DPT vaccine

This is an association of vaccines, which provides protection against diphtheria, tetanus and pertussis. To be effective, three doses must be given.

- Composition

The DPT contains an association of two toxoids (1) (tetanus and diphtheria toxoids) and one killed bacterial vaccine (pertussis) in a single vial.

- Preparation and packaging

It comes in liquid form, in 20 or 50-dose bottles containing 10 or 25 cc of vaccine.

- Storage

It should be stored in a refrigerator, between 0 and + 8 °C, and above all, it must never be frozen. Freezing modifies the appearance of the vaccine, and deteriorates it.

- Administration

It is administered by deep subcutaneous injection in the interscapulo-vertebral region or in the arm of thigh. The effective dose is 0.5 cc. The vaccine must be shaken before use. Three doses must be administered at an interval of at least 4 weeks, if the child is to be completely protected.

- Who should be vaccinated?

Children may be vaccinated from age 6 weeks on. Ideally, children should be vaccinated at 6, 10 and 14 weeks of age. Some countries recommend a booster dose one year later.

- Reactions to vaccination

During the first hours, the child may experience pain or fever, or cry. Parents should be warned of this, and advised to give the child a quarter of an aspirin, crushed in a little water.

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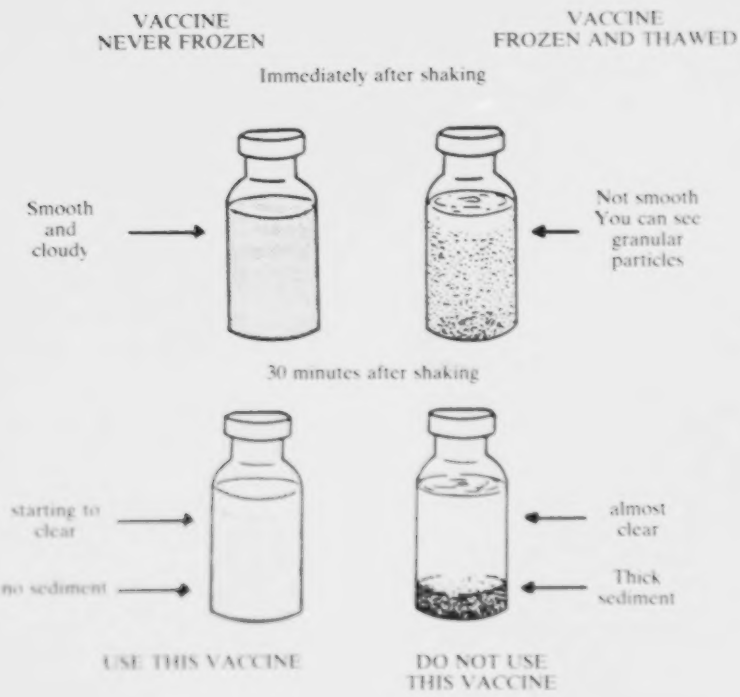
(1) A toxoid is a toxin modified by heat or by a chemical process, so that it is no longer toxic but induces the occurrence of antibodies in the body.

Figure 5

Testing DPT or TT vaccine for damage



Source: WHO. Immunizatson in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/1.

During the following days, the injection site may be slightly swollen and painful, with occasional occurrence of a nodule. This is not serious, and disappears in a few days.

2.3.3. The poliomyelitis vaccine

This vaccine exists in two forms: a live, attenuated virus, administered orally, and a killed, injectable virus. Here are the main differences between the two.

Figure 6

Position of child for DPT vaccine

Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/3.

CHARACTERISTICS	LIVE ORAL VACCINE	KILLED VACCINE
Protection	Good with 3 doses	Good, perhaps with only 2 doses
Cost	Inexpensive	Now very expensive
Side effects	Very rare, but severe (paralysis)	Pratically none
Administration	Easier. Oral route	Injectable. May be associated with DPT
Storage	Heat-Sensitive	Resistant to heat
Epidemic control	More effective. Mass protection	Less effective. Individual protection

Clearly, each vaccine has its advantages and its disadvantages. Most developing countries now use the oral vaccine. Changes may occur in some countries, however, since a new killed, concentrated vaccine, effective in only two injections, has been made available.

a) The oral vaccine

- Composition

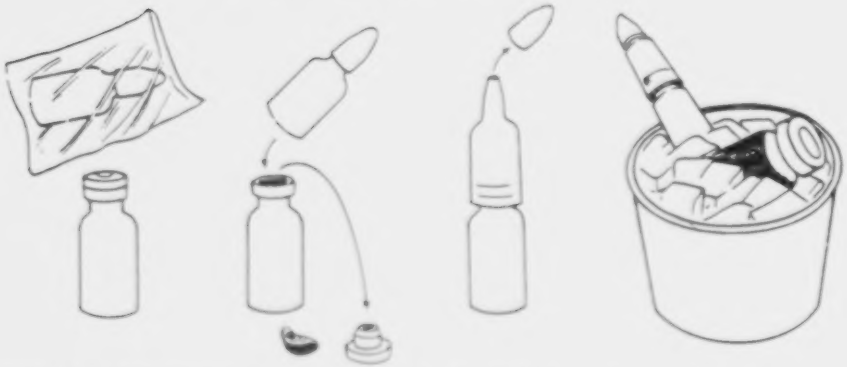
It is a suspension, containing live, attenuated polio viruses.

- Preparation and packaging

It is distributed in vials or bottles containing 20 doses. The cap of the vials has an incorporated dropper, while the bottles come with a dropper to be adjusted to the neck. The vaccine is pink or yellow, depending on the manufacturer.

Figure 7

Preparing OPV in Container 2
Putting the dropper onto the vial of vaccine
Standing the vial of vaccine in a pot of ice



Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/3.

Figure 8

Other type of vial

- Storage

The vaccine is heat-sensitive and must be kept in a freezer at − 20 °C, or in a refrigerator at 0 to + 8 °C. During the vaccination session, the bottle must be kept in a container filled with ice cubes, or an a cold pack. Once opened, the bottle must be used on the same day.

- Administration

The child is given 2 or 3 drops of vaccine, depending on the product. The drops are placed directly on the tongue, while the mouth is held open. Make sure that the child swallows them. If he/she spits them out, another dose must be given immediately. Vaccination should be performed even in case of diarrhoea.

Figure 9

Giving oral polio vaccine to a child

Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/3.

- Who should be vaccinated?

According to present WHO recommendations, children should be vaccinated at birth, and the 2nd, 3rd and 4th doses given at ages 6, 10 and 14 weeks, along with the DPT when possible. Some countries recommend a booster one year later.

- Reactions to vaccination

This vaccine does not produce any specific reaction.

b) The injectable vaccine

- Composition

It is a liquid, containing inactivated polioviruses.

- Preparation and packaging

It generally comes in association with the DPT, in liquid form, in single-dose 0.5 cc vials, in ready-to-use syringes or in 25 cc bottles (50 doses).

- Storage

It should be refrigerated at 0 to + 8 °C, and should not be frozen.

- Administration

The effective dose is 0.5 cc, administered by deep subcutaneous or intramuscular injection, to be repeated 2 or 3 times, depending on the product, at intervals of at least 4 weeks.

- Who should be vaccinated?

Children may be vaccinated at the age of 6, 10 and 14 weeks. Administration at birth has not yet been experimented.

- Reactions to vaccination

They are caused by the pertussis component; the poliomyelitis vaccine alone does not produce any adverse reaction.

2.3.4. Measles vaccine

- Composition

This is a live, attenuated viral vaccine.

- Preparation and packaging

It is composed of two parts: the freeze-dried vaccine, in powder form, settled in the bottom of a bottle, and the amount of diluent, required to reconstitute the vaccine. There are 10, 20 and 50-dose bottles, with 5, 10 and 25 cc of diluent respectively.

- Storage

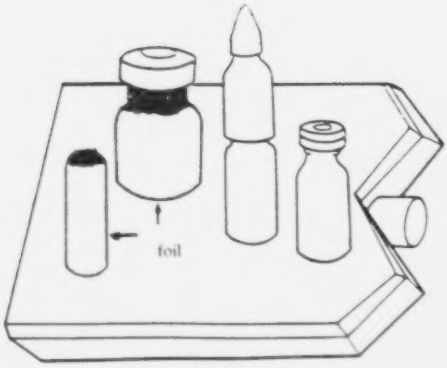
The freeze-dried vaccine is stored in a freezer at − 20 °C. It may also be refrigerated at 0 to + 8 °C for 3 months. The diluent should be kept in a refrigerator at 0 to + 8 °C. If there is not enough room to keep all of the diluent in the refrigerator, it should be placed there at least 2 days before vaccination.

To reconstitute the vaccine, the center of the cap of the bottle of diluent is removed. The stopper is pierced, using a large needle mounted on a 5 or 10 cc syringe. The content of the bottle is drawn into the syringe and injected through the stopper into the bottle of freeze-dried vaccine, using the same needle.

During its use, the bottle of reconstituted vaccine should be protected from light, and be kept in an ice-filled container or on a cold pack. The vaccine may then be used over a period of 5 to 6 hours, but should never be kept overnight.

Figure 10

Reconstituted measles and polio vaccine in a cup of ice



Vaccines standing on ice packs. BCG and measles wrapped in foil.

Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/3.

- Administration

It involves the subcutaneous injection of 0.5 cc of vaccine in the back, thigh or arm. Protection is afforded by a single dose.

- Who should be vaccinated?

Children are vaccinated from age 9 months on. Before the age of 9 months, many children still possess maternal antibodies against measles, and the vaccine would not be effective. Priority is given to vaccination of 9 to 12 month-old children, even if they have already had measles, since the mother's diagnosis may be erroneous. In addition, the vaccine is harmless in such cases.

- Reactions to vaccination

Moderate fever (38 to 39°) may be observed 6 to 10 days after vaccination in 20 to 30% of cases. A minor rash occurs in some rare cases. Parents are advised to give their child a quarter of an aspirin in case of fever.

2.3.5. Vaccination of pregnant women against tetanus

The tetanus vaccine is a toxoid; that is, a modified, attenuated tetanus toxin. Pregnant women are vaccinated in order to avoid neonatal tetanus, a most serious ailment, since 80% of its victimes die.

Figure 11

Giving measles vaccine

a) Inserting the needle

b) Injecting the vaccine

Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/3.

The vaccine should be refrigerated at 0 to + 8 °C, and should never be frozen.

Pregnant women are vaccinated by the subcutaneous administration of two 0.5 cc doses, in the arm, at an interval of at least 4 weeks. The first dose may be administered at the first prenatal visit (in any case before the end of the 7th month of pregnancy) and the second dose before the end of the 8th month. A woman who has received two doses transmits her protection to the child to be born. She need only be given a booster dose for subsequent pregnancies (within 5 years).

Many countries have chosen to vaccinate all women aged 12 to 45 years, by the administration of two doses at an interval of at least 4 weeks. Here too, they only need a booster dose during pregnancy, to protect their child.

After vaccination, the woman may experience pain, swelling or redness at the injection site for several days, and she should be warned of this.

2.3.6. Other vaccines

So far, we have discussed the vaccines against the 6 target diseases included in the EPI, as recommended by WHO. In some countries, however, other major diseases occur and may also be avoided by vaccination.

- Yellow fever

This is a serious, often fatal disease which is endemic in central and western Africa as well as in Latin America, with local-regional epidemics from time to time.

The vaccine is composed of a live, attenuated highly heat-sensitive virus which should therefore be refrigerated at 0 to + 8 °C. It comes in powder form, in vials containing 5 to 100 doses, to be reconstituted with 2.5 or 50 cc of diluent, respectively. Once reconstituted, it must be used within one-half hour, and kept in ice and water. Inoculation is subcutaneous, at a dose of 0.5 cc.

A slight fever may occur between the 4th and the 7th day; aspirin relieves it rapidly.

Children may be vaccinated from ages 9-12 months on. Pregnant women should not be vaccinated.

- Meningitis

There are different types of antimeningococcal vaccines: A, C or A + C. They come in 25 cc bottles of 50 doses for subcutaneous injection, for children over 3 months old, in the case of A, 18 months old for C and A + C. The effective dose is 0.5 cc. It is mostly used in epidemics, but some countries include it in their routine immunization programmes.

It should be stored in a refrigerator at 0 to + 8 °C. It may be associated with the DT and measles vaccines, and does not produce any side effects.

- Hepatitis B

Hepatitis B is a major health problem in many countries, including developing countries.

The vaccine was made available in 1980, and is currently recommended for some at-risk groups and for some types of workers. Three doses are required, at one month intervals, with a booster dose one year later. There are no contra-indications, and reactions are quite mild. This vaccine is most valuable in the developing countries, for it would eliminate a great many cases of chronic hepatitis and primary cancer of the liver. Its disadvantage is the high cost of its production.

2.4. Vaccinal associations

Some associations of vaccines are effective and harmless. They save time and reduce the number of consultations for vaccination.

There are two types of association:

— **combined** association: the vaccines are mixed in a single vial or a single syringe;
— **simultaneous** association: the vaccines are administered at the same time, but on different parts of the body, sometimes by different routes and techniques.

The association of vaccines included in the EPI generally raises no problems. For example, a child aged 9 months or more and who has never been vaccinated may be given an injection of DPT in the right arm (this in itself is a combined association of diphtheria,

tetanus and pertussis vaccines), the BCG in the left arm, intradermally, the measles vaccine in the thigh and the poliomyelitis vaccine orally.

2.5. Contra-indications for vaccination

Some years ago, there were so many contra-indications that it was difficult to vaccinate a child. Any child with a slight fever or diarrhoea was denied vaccination and called in again several weeks later. Often he/she was still ill the next time, and was only vaccinated at a late date, sometimes never. It has now been discovered that most sick children may be vaccinated. There are no severe reactions, and the child is protected as well as any healthy child.

At present, WHO recommends that the health team inquire into vaccinal status each time a child is encountered. This means that **whenever a child** arrives in a clinic, health centre or hospital, the vaccinations listed on his/her vaccination card must be checked. They should be completed when necessary, even if the child has a slight fever, a running nose or diarrhoea.

Only when the child is severely ill is vaccination delayed. In that case he/she should be hospitalized.

Children with malnutrition should also be vaccinated. If they were not vaccinated they might develop a more serious form of the disease than would a well-nourished child. In addition, vaccination is effective and well tolerated by these children.

The only contra-indication, aside from severe illness, involves convulsions or major neurological disorders. Such children should not be given the pertussis vaccine. The DT vaccine is administered without the pertussis fraction.

2.6. Immunization schedules

An immunization schedule is a table showing the recommended age for vaccinating children. Each country should establish its own schedule according to the epidemiological needs and characteristics of the population.

WHO now recommends the following model schedule:

— at birth: BCG + oral polio;
— 6 weeks: DPT + oral polio;
— 10 weeks: DPT + oral polio;
— 14 weeks: DPT + oral polio;
— 9 months: measles.

This schedule is for children under 12 months old with easy access to health centres. As a rule, boosters are given at:

— 18 months: DPT + polio;
— 5-6 years: DT + polio.

The following schedule is suggested for teams making only 3 visits a year. During the first visit, the following vaccines are administered, depending on the child's age:

— under 6 weeks: BCG + oral polio;
— 6 weeks to 9 months: DPT + oral polio;
— 9 months or over: DPT + oral polio + measles.

Vaccination is completed on the following visits, depending on the child's age. A child is not considered completely vaccinated until he/she has received:

— 1 dose of BCG;
— 3 doses of DPT and 4 of polio;
— 1 dose of measles vaccine after age 9 months.

Some trials are now under way to test new, simpler schedules, which would improve vaccinal coverage. A schedule based on two visits at 6-month intervals is being studied, using the concentrated injectable poliomyelitis vaccine, in association with the DPT. The following vaccines are administered on the first visit:

— children aged 3 to 8 months: BCG + DPT-polio (1st dose);
— over 9 months old: measles + DPT-polio (1st dose).

On the second visit, 6 months later:

— children aged 3 to 8 months: BCG + DPT-polio;
— children aged 9 to 15 months: measles + DPT-polio (2nd dose);
— children over 15 months: DPT-polio (2nd dose).

The first results of studies done in difficult-to-reach rural areas show high vaccinal coverage rates (60%) after two visits, at a reasonable cost despite transportation and the high cost of the vaccine.

2.7. Important remarks and practical matters

The minimal interval between doses is one month, for the DPT and polio vaccines. There is no maximum interval. If the series is interrupted it should never be started over. It should simply be completed, starting where it was left off.

Do not vaccinate against measles before age 9 months. During epidemics, when children may be vaccinated at 6 months on the explicit orders of the ministry, less satisfactory protection may be expected, and a second dose should be given after age 12 months.

Here are two concrete examples:

— a 9-month-old child has not yet been vaccinated at all. What should be done? It is possible to administer, the following vaccines, all on the same day: BCG (left arm), DPT (right arm or subscapular region), polio (mouth) and measles (thigh). The reactions to vaccination will be the same as usual, and the child will be well protected. The second and 3rd doses of DPT and polio will be administered 4 and 8 weeks later;
— a 7-month-old child has not yet been vaccinated at all. On the first day, the first dose of DPT, polio and the BCG may be administered. 4 weeks later the second dose of DPT and polio are given. 4 weeks after that (he/she will then be 9 months old), the measles vaccine will be given along with the 3rd doses of DPT and polio.

Slightly ill or malnourished children should be vaccinated normally.

Vaccination of premature infants is the same as for full-term babies.

A vaccine should always be administered at the same site, in accordance with the instructions given in each country. This makes it easier to assess the effectiveness of the BCG vaccine, since the scar is always in the same place. Furthermore a lost vaccination card may then be replaced, after questioning the mother.

Pregnant women who have never been vaccinated against tetanus should be given two doses of vaccine: one on the day of the first consultation, the second during the third trimester of pregnancy (up to the end of the 8th month). If the woman has already been vaccinated at school or during a previous pregnancy), she should only be given a booster dose during the third trimester. No other vaccine should be given to a pregnant woman.

Vaccination of injured or burned individuals, or of those with chronic skin ailments: the following table shows the treatment to be given to an injured adult, depending on the seriousness of the wounds and the person's vaccinal status.

	CLEAN OR MINOR WOUNDS		SERIOUS OR DIRTY WOUNDS	
	Vaccine	Serum or immune globulin	Vaccine	Serum or immune globulin
Complete series Booster less than 5 years ago	0	0	0	0
Incomplete series Booster over 5 years ago	1 injection	0	1 injection	2 vials
Never vaccinated or does not know	1 series of vaccine	1 vial	1 series of vaccine	2 vials

3. ORGANIZATION OF VACCINATION

Vaccines are available, we know who should be vaccinated and what technique should be used. There remains the question of the organization of vaccination. Perhaps this is the most important and most difficult task.

How is the stock of vaccines to be managed? How is an immunization programme established for a village or a large town? How should a vaccination session be organized so that it is effective, mothers are satisfied and children correctly vaccinated? How should the facilities for the cold chain be used for the storage of vaccines? All of these points require close examination.

3.1. Immunization strategies

There are 4 different basic strategies for immunizing a given population group. The choice of one strategy depends on a number of factors, of which the geographic location, resources, personnel and facilities available are the most important.

The first possibility is a **static** or **fixed-point** strategy, which involves the organization of vaccination sessions at set times, on a permanent basis. Vaccination is performed by the personnel employed by the health centre and integrated in primary health care. The personnel remains in the establishment and vaccinates the target individuals.

This strategy is generally used in cities, where the population requiring vaccination is large. It is easy to manage and less expensive. However, its success depends on satisfactory participation of the population, and the high quality of the services provided by the health centre.

In most developing countries a static strategy would not achieve proper vaccinal coverage, owing to the scattered habitat. People living too far away would not come to the centre for vaccination. In such cases, an **advanced-point** strategy is used. **In addition to** the fixed-point activities in the health centre, the personnel travels to secondary outposts, clinics or centres located in the surrounding area, in villages where there are no existing health structures. This is more expensive than a static programme, due to the cost of transportation, the personnel and the equipment required for the cold chain. Bicycles and motor cycles are used.

The **mobile** strategy calls for a travelling team whose headquarters is not a health centre but the regional health department. These are health workers who visit outlying areas where there is no health establishment, no cold chain or insufficient personnel. They generally make whole-day or several-day visits, using a vehicle to transport workers and equipment.

The **mass campaign** strategy has now been reinstated as an effective means of rapidly increasing vaccinal coverage and mobilizing an entire community for a single objective. It requires the cooperation of several structures, a firm political will, satisfactory coordination and popular participation. The aim is to vaccinate a great many children in a short lapse of time, with the participation of volunteers, the creation of many places of vaccination and the use of intensive publicizing. This is a very costly strategy and generally requires the help of international agencies.

3.2. Organization of the session itself

A vaccination session must be organized in such a way that:

- all children in the target age group are correctly vaccinated and the mothers properly guided;
- mothers do not wait too long and are satisfied, so that they will return gladly;
- the health agents have the best possible working conditions;
- the population is informed in advance that the session will be held;
- vaccination is integrated in other health activities, such as the treatment of common diseases and symptoms, weighing and recording of weight, health education, etc.

Here are the main steps to be taken for the proper preparation of a vaccination session.

3.2.1. Programming the sessions

An accurate timetable must be established. The day, hour and place at which the sessions are held must be convenient for mothers, so that they may bring their children in. The sessions must be sufficiently frequent, so that the number of children seen at each session is not excessive, mothers do not have too long a wait, and the personnel has time enough to vaccinate all of the children.

The timetable should be respected, so that people may be well informed of the vaccination days. Non-respect of the timetable may have serious consequences: children will not be vaccinated under satisfactory conditions, and people will be discouraged and will no longer participate in activities organized by the centre.

3.2.2. Number of children requiring vaccination

In most developing countries, children under one year old represent 3 to 4% of the overall population. In order to determine the number of children requiring vaccination in the course of one year, the total population served by the health centre should be multiplied by 4% (0.04).

Number of children requiring vaccination each year = total population × 0.04

The number of pregnant women requiring vaccination against tetanus may be considered to be the same.

Next, the number of vaccinations to be performed during the year should be calculated. Each child receives 3 doses of DPT + polio, 1 dose of BCG and 1 dose of measles vaccine. The average number of the child's "contacts" with the health centre may thus be estimated at 4, although 5 operations are planned (sometimes the 1st DPT + polio and the BCG are associated at 3 months, or the 3rd DPT + polio and the measles vaccine at 9 months). This means that each child will visit the centre approximately 4 times to receive all vaccines.

Vaccinations to be performed each year = No. of children requiring vaccination each year × 4

To calculate the number of children who will be brought in for vaccination each month, the last figure should be divided by 12.

For example: your health centre serves a population of 10,000 inhabitants. There will therefore be 400 children requiring vaccination each year (10,000 × 0.04), and 1,600 contacts per year (400 × 4), which means approximately 133 children coming in for vaccination each month (1,600 : 12).

This figure conditions the decision as to the number of sessions to be organized each month. The following factors must be taken into account:

— the number of children the personnel is capable of vaccinating in one session (20, 40, etc.);
— the geographic location of these children: all in a town, or in scattered villages;
— the number of sessions possible, the personnel available, the type of activities (are all activities static or do mobile activities exist as well);
— the packaging of vaccines. As a rule, they are packaged in multiple-dose bottles (10 or 20), and a number of children should be brought in together, so as to use as much of the vaccine as possible. If only 50-dose bottles are available, it is more difficult to organize "small" sessions without wasting much of the vaccine. It is best to bring 35 to 45 children together in that case.

As a rule, a session is organized when there are at least 20 children to be vaccinated. In our example, if there are 133 children requiring vaccination each month, 7 monthly sessions will be required. The number of children vaccinated at each session may also be increased, and the number of sessions then decreased. It is important that the sessions be held regularly; for example, twice a week, every Tuesday and Thursday.

In the case of a catch-all or booster programme — that is, a newly implemented programme in the area — children over one are also vaccinated (usually those aged 0-2, 0-3 or even 0-4 years). A greater number of sessions should then be planned, and a greater number of children expected.

3.3. Managing the stocks of vaccine

It is most important that the required amount of vaccine be available. If the amount is insufficient, vaccination will be delayed. If there is too much, some may be kept beyond the expiry date, and will have to be discarded.

The procedure for evaluating the amount of vaccines needed is described below.

Let us suppose a population of 12,500 inhabitants; there are therefore 500 children under 1 year old (see paragraph 3.2). First we must calculate how many of these children will be vaccinated. If we estimate, for instance, that 80% of these children should be vaccinated this year, the calculation is: $500 \times 0.80 = 400$ children.

Vaccination of children under one requires 1 dose of BCG, 3 doses of DPT, 3 doses of polio and 1 dose of measles vaccine. 2 doses of tetanus vaccine are required for the vaccination of pregnant women.

For each vaccine, we must calculate the number of doses to be administered: multiply the number of children to be vaccinated by the number of doses to be administered.

For example:

— BCG: $400 \times 1 = 400$ doses;
— DPT + polio: $400 \times 3 = 1{,}200$ doses;
— measles vaccine: $400 \times 1 = 400$ doses.

In reality, however, the amount of usable vaccine in a multiple-dose vial is smaller than its theoretical contents. This amount may be calculated on the basis of the **utilization rate;** that is, the average amount of vaccine which may really be used in each vial.

The utilization rate is 50% (0.50) for the BCG and 75% (0.75) for the other vaccines.

No. of doses of vaccine needed =	No. of doses to be administered	:	utilization rate of the vaccine

In our example, we will need:

— BCG: 400/0.5 = 800 doses;
— DPT and polio: 1,200/0.75 = 1,600 doses;
— measles vaccine: 400/0.75 = 533 doses.

To vaccinate pregnant women against tetanus, 1,066 doses are required (400×2 doses = 800 doses/0.75 = 1,066 doses).

The vaccines should normally be delivered to health centres every month. The figures for the annual needs should therefore be divided by 12, and the result then divided by the number of doses contained in a bottle of vaccine. This shows the number of bottles required:

— for the BCG (vials containing 10 doses): 800/12 = 66.7 doses, or 7 vials containing 10 doses;
— for the DPT and polio (bottles containing 20 doses): 1,600/12 = 133 doses, or 7 bottles containing 20 doses;
— for measles (bottles containing 10 doses): 533/12 = 44.4 doses, or 5 bottles containing 10 doses.

For the tetanus vaccine (bottles containing 20 doses), 5 bottles will be needed (1,066/12 = 88.8 doses).

As a safety measure, the amount of vaccine ordered should be one third above the expected needs, so that the stock available at the beginning of the month covers needs, plus a reserve.

This reserve should only be ordered on the first month; it is unnecessary to do so on the following months. Each month thereafter, the amount ordered represents what is needed to complete the stock; that is, to reach the level of monthly needs + reserve, taking the unused stock into account.

In the case of a catch-all programme, additional vaccines should be ordered. The amount depends on the age group covered, but the rule applied is the same. Similarly, the amount of tetanus vaccine ordered should be increased if national policy prescribes the vaccination of all women aged 15 to 45, rather than pregnant women only.

Furthermore, some countries recommend that the static centres check on the vaccinal status of all women and children seen there, regardless of whether they are consulting for treatment or simply accompanying another person. In this case one bottle of vaccine should be ordered for each consulting day in the month; that is, approximately 20 bottles of BCG, DPT, polio, measles and tetanus vaccines.

3.4. Implementation of a vaccination session

3.4.1. Preparation

In the best of cases, a health centre should attempt to set up a waiting room and vaccination room with two doors, at opposite ends, if possible, one as an entrance, the other as an exit.

For mobile sessions, organized outside of the health centre, a visit must first be paid to the village in which the session will be held. The community leaders should be consulted, the programme and the activities explained, the material facilities organized (place, furnishings, etc.), and the best day for the session chosen. It is best to hold sessions systematically on the same day of the week or month, at the same place, and at the same time.

Preparation of the equipment. The following are needed:

• For record-keeping:

— a table and two chairs (for the secretary and the mother);

— a record book;
— growth charts for new children;
— a monthly listing card for vaccination;
— a pen or pencil.

• For the surveillance of growth:

— a baby-weighing scale;
— if possible, a measuring stick.

• For sorting out and treating children:

— a table and two chairs;
— drugs.

• For vaccination:

— a table and two chairs;
— a cold box for vaccines, containing ice or cold packs, with the vaccines and diluents;
— a file;
— pincers without clamps for holding needles;
— cotton and a disinfectant;
— an ice-filled bowl for keeping vaccines cold during use, or an extra cold pack;
— a sheet of black paper or of aluminum to cover the BCG and measles vaccines (to protect them from light);
— a tray on which to place used syringes and needles;
— an alcohol-burning lamp for flaming the tip of BCG needles, if that type of material is used.

• For the vaccines:

— large, 5 or 10 cc syringes with a long needle, for the reconstitution of freeze-dried vaccines;
— 1 cc Omega syringes graduated to 1/100, with 10 mm intradermic needles;
— 1 or 2 cc syringes, with 30 mm needles for subcutaneous or intramuscular injections.

Needles and syringes are kept in closed metal boxes. They are sterilized before each session (see chapter on sterilization).

To calculate the number of syringes and needles required, the number of children expected at the session must be estimated, and some extra material provided.

For 50 children, for example, there will be an average of:

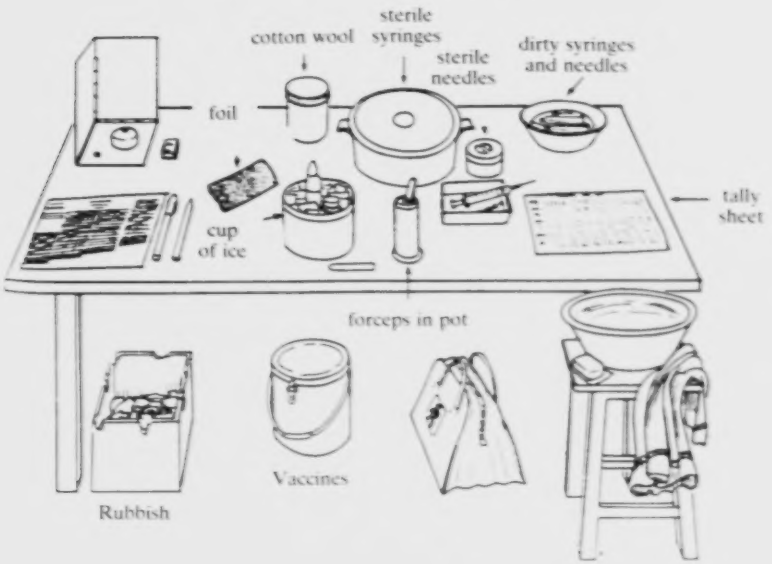
— 10 children for the BCG, requiring 2 Omega BCG syringes (one syringe for 10 children + reserve) and 15 BCG needles;
— 40 children for the measles and DPT vaccines, requiring 40 1 or 2 cc syringes and 45 needles for subcutaneous injections;
— 4 10 cc syringes and 6 large needles for the reconstitution of the BCG and measles vaccines, and for taking the DPT from the multiple-dose bottle.

With the exception of the intradermic needles, which are flamed (for the BCG), a new needle is used for each child. Ideally, a different syringe should be used for each child as well. WHO now stresses this point strongly, to avoid transmission of some diseases.

• Specific aspects of some programmes

Figure 12

Equipment on Immunization Station Table



Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/5.

In some contexts, original techniques may be used for the injection of vaccines and the organization of sessions.

During mass campaigns or large-scale actions, in underprivileged rural areas in particular, when children over one year old, and often as old as 4 or 5 are vaccinated, a heavier structure is required.

When the number of injections of a given antigen within a single session exceeds 100, needleless pressure-gun injectors are often used. They are easy to handle, their performance is good, sterilization is rapid. They require care and repair work, however, and this entails trained workers and the availability of spare parts.

Only those antigens administered subcutaneously or intramuscularly may be injected in this way. Inoculation of the BCG still requires use of a syringe.

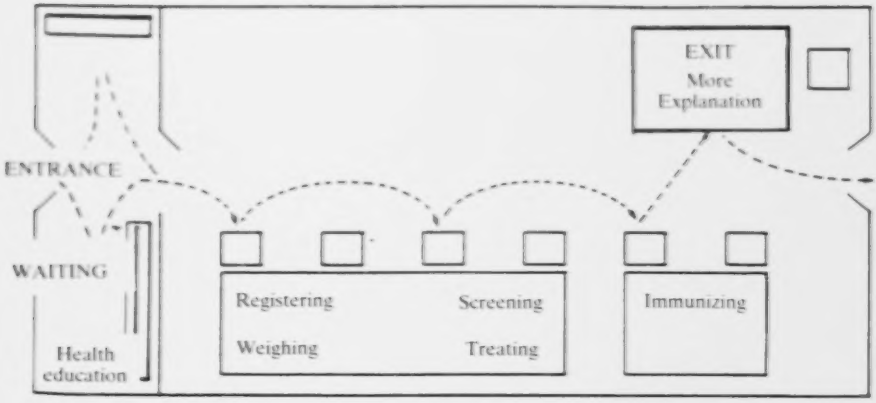
3.4.2. Material arrangements

This depends mostly on where the session is held and on the number and degree of training of the workers available.

First, a practical circuit must be planned to make sure that mothers necessarily pass through all of the stations. A good example of this is given below.

Figure 13

Plan of an immunization site in a building



Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/5.

If the session is to be held outdoors, look for a shaded spot. The different stations are organized much in the same way. Here is an example of a session involving three stations, 2 nurses, 1 community health agent and 1 local volunteer.

The tasks to be done at the different stations are as follows:

— the waiting room (or a designated place for waiting). Mothers must be able to remain seated. The organization of collective health education sessions in this room is recommended;
— the record-taking station: the cards of children who have already been seen are taken out, a card is prepared for each new child, growth charts and vaccination cards are filled out and distributed, the record-books are filled out;
— the weighing and measuring station: curves are drawn on the growth charts;
— the treatment station: the mother is questioned and the child examined rapidly. Available drugs are distributed in accordance with the conclusions most essential for a treatment station are aspirin, chloroquine, penicillin, vitamins (especially vitamin

A), iron and anti-parasitic drugs. Oral rehydratation solution is also an important element. The child's weight curve and nutritional status are also checked. Advice on diet is given;

Figure 14

An immunization session with three stations, two health workers, a community health worker, and a village volunteer

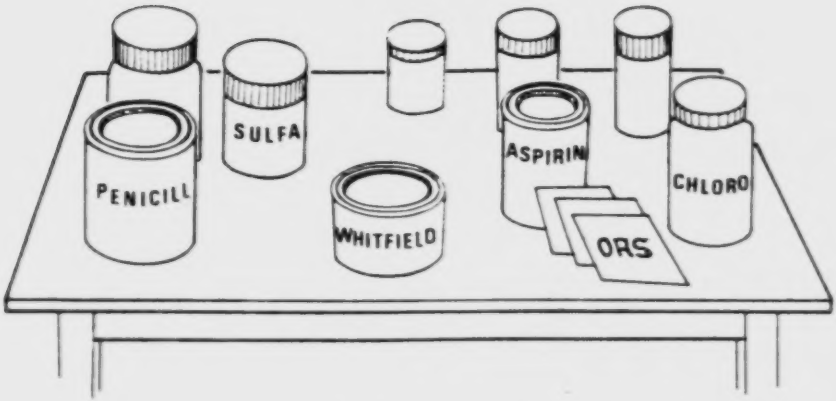
Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/5.

The child's vaccinal status is checked, using the table included in the growth chart, a decision is made as to what vaccines to administer, depending on the child's age, and he/she is sent on to the next station;

— One or two vaccination stations for injections of DPT, measles and BCG vaccines and for the oral poliomyelitis vaccine. Reactions to vaccination are explained here, and a reminder made of the next appointment. This is extremely important. A daily listing is made here of the vaccines administered. Figure 17 shows an example of such a record;

Figure 15

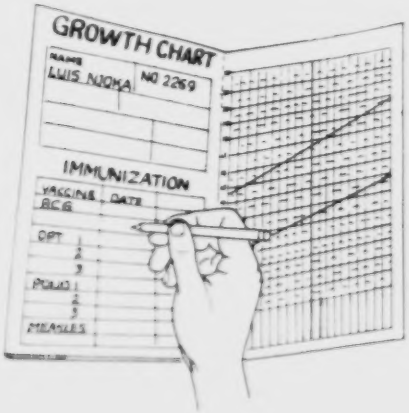
The treatment station



Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/5.

Figure 16

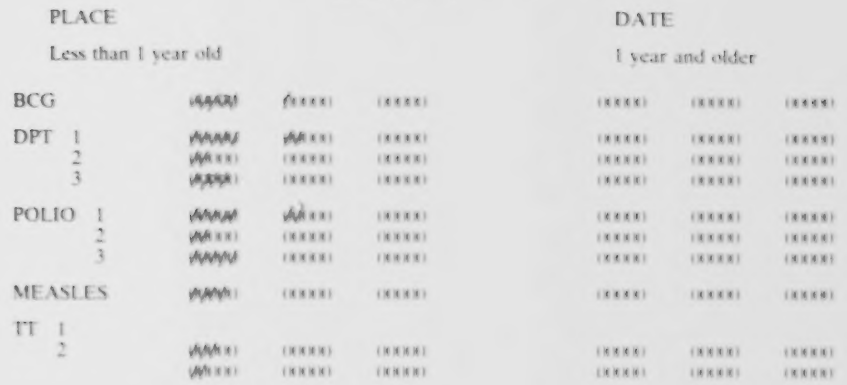
Filling in the immunization section of a growth chart



Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/5.

Figure 17

The tally sheet



Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/5.

In this example (Fig. 17), 6 children were given the BCG, 7 a first dose of DPT and oral polio, 2 a 2nd dose of DPT and polio, 4 a 3rd dose of DPT and 5 a 3rd dose of polio. 4 children were vaccinated against measles, 3 mothers received a 1st dose of tetanus vaccine and 2 a second dose. No child over one year old was vaccinated.

— an exit station may be added, to make sure that the child has been vaccinated and the mother has been informed of the reactions to vaccination and of her next appointment.

When the team is small, several stations may be combined. For instance:

— one person keeps the records, weighs and treats, decides what vaccinations to perform, fills out the growth charts and sets the next appointment;
— one person vaccinates, explains the possible reactions to vaccination, establishes the daily listing for the session and fills out the vaccination card.

3.4.3. Record-keeping

This is, perhaps the most difficult of activities related to vaccination, but a most important one as well. The main objectives of record-keeping are as follows:

• to furnish each vaccinated child with an individual vaccination card or, better still, with a growth chart **including** a listing of vaccinations. The family must be made to understand the importance of keeping this card.

• to keep a daily and monthly listing of vaccinations performed, including the type of vaccine, series and child's age, as well as a record of the other activities run by the centre. This will be useful in determining:

— the amount of vaccine used;
— how much is needed for the future;
— losses;
— the percentage of target children who were actually correctly vaccinated, the drop-out rate between successive doses of DPT and polio (see chapter 6.2.: "evaluation of vaccinal coverage");
— cases of target diseases and deaths caused by target diseases (see chapter 6.3.: "disease surveillance").

Figure 18

Monthly vaccine supply report for a health centre

VACCINE	SUPPLY AT BEGINNING OF MONTH	AMOUNTS RECEIVED	NO. OF PERSONS VACCINATED	NO. OF DOSES LOST	SUPPLY AT END OF MONTH	DOSES/BATCHES		EXPIRY DATE
BCG								
DPT								
ORAL POLIO								
MEASLES								
YELLOW FEVER								
MENINGO								
TETANUS								

• to keep individual growth charts, at the centre when possible; if not, to keep records on which the children attending the centre and their vaccinal status are noted.

All this is also valid for mobile activities, when feasible.

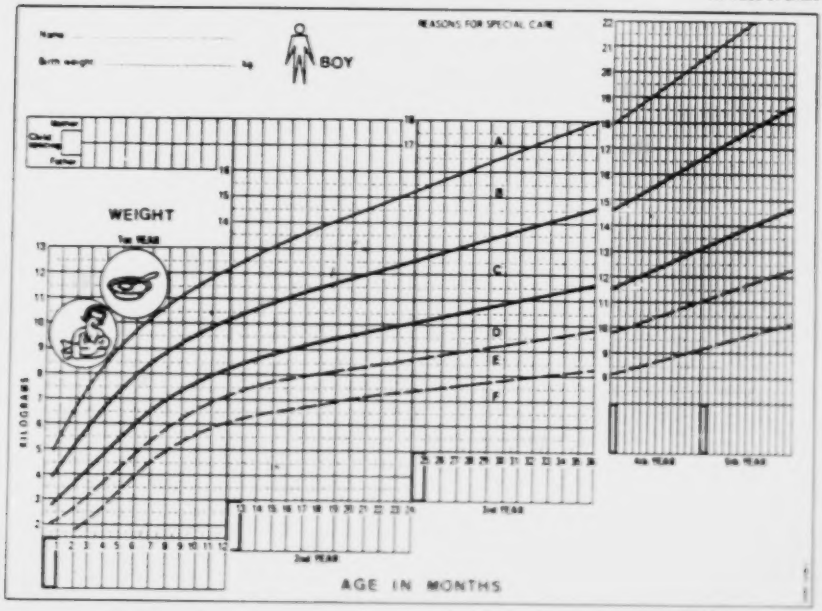
There are several ways of recording vaccinations at the health centre. The listing shown below is a good example. Each country has its models for record cards.

Daily reports should be assembled into monthly reports and sent by the person in charge to a higher echelon (main office for the province, etc.).

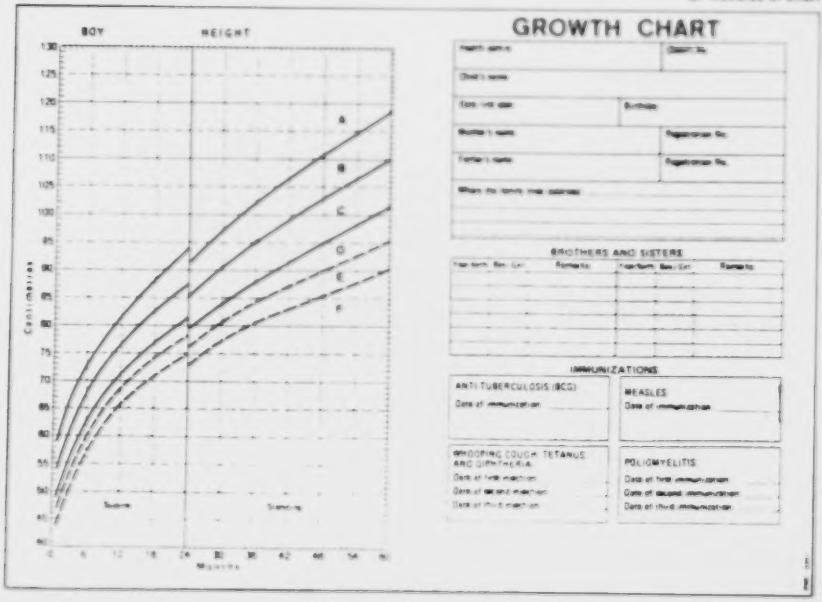
Figures 19

Weight and height curves

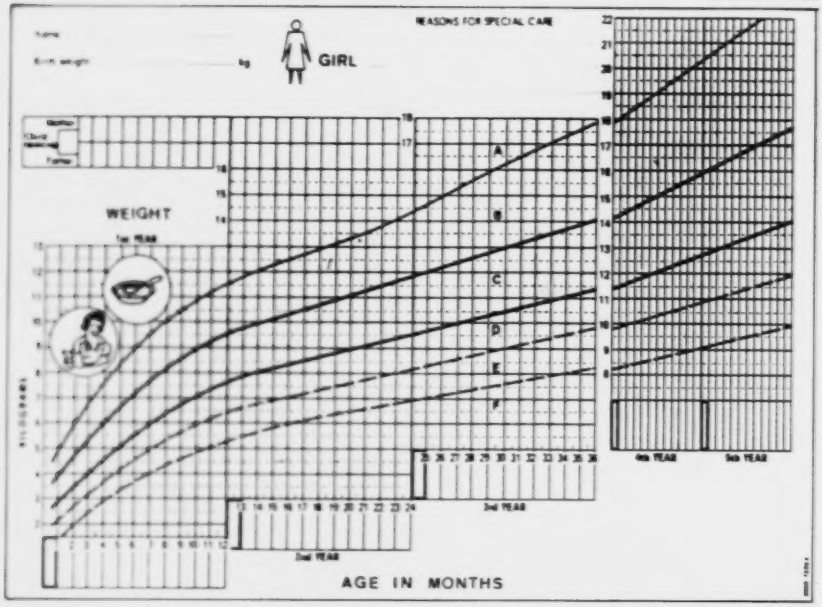
A. Face of chart



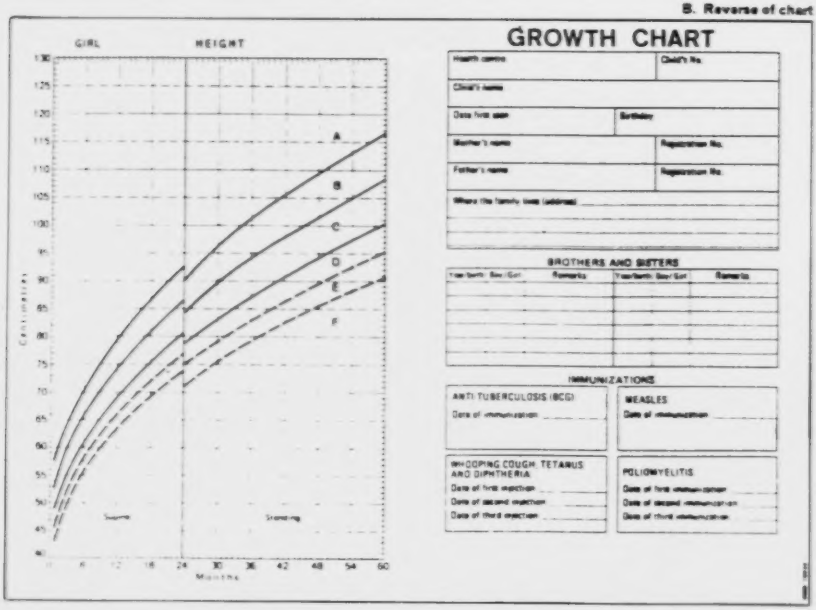
B. Reverse of chart



A. Face of chart



B. Reverse of chart



4. COMMUNITY PARTICIPATION

The most perfect vaccination programme, with the best trained personnel, excellent vaccines and material resources will be a complete failure if people do not come to be vaccinated. Community participation is therefore essential if the objective of the programme is to be achieved.

Parents bring their children to be vaccinated if **they themselves** believe it to be important. They must therefore be **motivated,** and made to understand that vaccination is very important for their children. This is the objective of health education.

4.1. Active participation of the community

When beginning an immunization programme, in a village for instance, those people who may be instrumental in organizing it should be sought out. These may include political and religious leaders, associations, women's groups, traditional healers, teachers, etc. They may be invited to meetings at which the problems of disease, the importance of vaccination and the objectives of the programme are explained, and their opinion sought as to the best times and places for vaccination sessions, possible problems, and ways to motivate the community. They may also be asked to help in explaining the programme to the community and motivating people to come for vaccination.

Volunteers may be called upon for a variety of tasks: during the sessions they may help in weighing children, checking cards, informing mothers. They may also remind people of the date of the next session, and explain the need to bring their child to it. They may fetch those children who were not brought in spontaneously, according to a list established by the health team, or make a count of new children requiring vaccination: newborns, children freshly arrived in the village, etc. They may even participate in disease surveillance, or help to identify the onset of an epidemic, for example. All of these tasks require some training.

4.2. Health education

In addition to active community participation, it is most important that parents be well informed about vaccination, and that they understand how important it is. They must therefore receive information about:

— the target diseases and the threat represented by them;
— vaccination, a simple, harmless way of protecting children;
— the schedules, and the proper age for vaccination;
— the need for several doses of some vaccines;
— the reactions to vaccination.

Several methods may be used to transmit these messages, which are in fact often more clearly comprehended when they are formulated and communicated by people from the community. These methods include:

— discussions: during vaccination sessions, for example, discussions are organized with waiting mothers. They are given information, while the waiting time is made more pleasant. These discussions may be organized at any time, not only during the sessions. Questions should be asked, and people encouraged to speak. Schoolchil-

dren too may be taught about vaccination, so that they will discuss it with their parents;
— posters, slides and films may be used to awaken parents' interest before a discussion. Role-playing and theatre play may also be organized, songs and slogans invented, stories told, etc.;
— radio and television are good means of transmitting clear, comprehensible information;
— political and religious authorities may comunicate educational messages.

Figure 20

A group health education session

Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/6.

Figure 21

A visual aid - a poster to help teach about giving tetanus toxoid

Source: WHO. Immunization in practice. A guide for Health Workers who give vaccines. Geneva: WHO, 1984. EPI/PHW/84/6.

Several important points should be respected in the field of health education:

— always be polite with parents, greet them when they arrive, make sure they are properly seated and that the wait is not too long. In other words, make the session as pleasant as possible;

— information may be given at all times. There is no need to wait for specially organized discussions; information is provided throughout the session, before and after it, during visits to a patient at home: people's questions are answered, their curiosity excited, etc.;
— in any talks with parents, always ask for their opinion, inquire into their experience in the field, and above all, ask them whether they have any special questions or concerns. During group discussions, encourage their participation;
— use visual aids whenever possible (films, photos, drawings, etc.), so as to clarify explanations and make them more pleasant;
— check on "key points" during the session:
  - does the mother understand why her child has been vaccinated, and against what disease?
  - does she understand that several doses of DPT and polio are required for immunization?
  - does she know when to come again?
  - is she informed of possible reactions to vaccination?
— whenever possible, combine other health activities with vaccination. People are more motivated for having their children weighed and treated than for vaccination;
— inform the community of the results of the programme: how many children were vaccinated, what change may be seen in the number of cases of measles, for example.

5. TRAINING PERSONNEL

The personnel is an important part of any immunization programme. At all levels, workers must be well informed and motivated. They must know what they are doing and why.

This requires the organization of ongoing training. Vaccination is not a particularly difficult technique. It does involve some extremely important, specific technical knowledge, which must be properly assimilated.

All personnel involved in immunization should be trained, be it the vaccinator participating in a mobile team or the national administrative official.

For these different types of personnel, WHO has established several highly didactic, practical teaching programmes, which are easy to follow. Some countries have also set up their own courses and training programmes. Seminars, technical meetings and refresher sessions are held either at a local level or centrally.

Officials in charge of programmes also organize meetings for training and the exchange of information for their own personnel.

Last, supervisory visits also provide an opportunity for on-the-job training, the up-dating of theoretical knowledge and reflexion on how to solve the problems encountered.

6. EVALUATION OF IMMUNIZATION PROGRAMMES

All immunization programmes must be continually evaluated. They may thus be reformulated and improved, so that their objectives may be achieved.

This evaluation may cover various aspects of the programme:

— supervision of activities;
— vaccinal coverage;
— disease surveillance;
— the quality and efficacy of vaccines;
— the proper functioning of the cold chain;
— the cost of the programme;
— integration with other primary health care activities.

6.1. Supervision of activities

Contacts made during supervision provide a good opportunity to evaluate the quality of immunization services. The supervisor is also a link between personnel working in outlying centres and the central units of the programme. He/she talks with them, motivates them and attempts to answer their questions. These discussions deal with the different aspects of the immunization service: record-taking, the proper functioning of the cold chain, the correct administration of vaccines, the relations between the centre and the community it serves, mobile activities, the management of the stocks of vaccine.

According to Stan Foster, epidemiologist at the Atlanta Centers for Disease Control, a supervisor may get some idea of the success and weak points of an immunization programme by examining the following points.

6.1.1. The supply system

Does the personnel dispose of enough vaccines to do its work? All levels of the distribution of vaccines are concerned by this problem. Chapter III point 3 has described the way to calculate the amount of vaccines needed for one month of work. Once the time needed for delivery and the supply remaining at the end of the month are known, the amount of vaccine to be ordered may be evaluated, so that the centre will never be out of stock. The supervisor examines the supply cards and questions workers, in order to determine how many doses of vaccine are lacking, and why, since a shortage always hinders the application of the programme.

6.1.2. The cold chain

If a vaccine is to retain its high quality, it must be kept at the right temperature. Daily measurement of the temperature of vaccines over a one-month period furnishes an indicator: the relationship between the number of days of the month during which the temperature was comprised between 0 and + 8 °C and the number of days on which the temperature was measured may be calculated.

For example, the head physician established the following table during a visit to four health centres.

Surveillance of vaccine temperatures in health centres

Health centres	No. of days/mth on which temperature was measured	No. of days/mth on which temperature was between 0 to + 8 °C
A	25	10
B	0	0
C	25	25
D	15	10

If your own child required vaccination, and you had access to this table, which health centre would you choose? No one would hesitate about this.

6.1.3. Providing service

The community's confidence in the health personnel, attendance at vaccination sessions and active participation depend to a large extent on the personnel's ability to carry out the planned activities. Non-fulfillment of a programme destroys confidence. For this reason it is useful to compare planned activities with those actually implemented, both in static centres and during visits by mobile teams.

Here too, a table may be established, with the help of the personnel, to indicate the failings of the programme.

Vaccination activities in health centres

	Static	Mobile
Planned	10	6
Implemented	9	2
Percentage of implementation	90 %	33 %

6.1.4 The quality of service

During a supervisory visit, some time will be spent in observing the personnel at work.

Is the vaccine cold? Is it correctly reconstituted, using cold diluent? Is the proper amount of vaccine inoculated? Are the injections performed with a sterile needle, and at the right place?

Is the vaccinal status of all children present checked? Is the prescription of a vaccine in agreement with the national schedule, with the child's age and previous vaccinations? Are children whose vaccinations are not complete given the necessary complement? Are mothers informed of the reactions to vaccinations, and what should be done? Do mothers know whether they must come again, and when?

Perhaps the best way to determine the quality of the service is to question mothers leaving a vaccination session!

6.2. Evaluation of vaccinal coverage

Another essential part of the evaluation of an immunization programme is the knowledge of the percentage of the target population which has been correctly vaccinated. Two methods may be employed for this evaluation:

— evaluation based on activities reports: the activities reports of health centres provide figures for vaccination, for each vaccine and usually for each age group. If this figure is divided by the estimated number of individuals in that age group in the area, the result is the percentage of those children who have been vaccinated.
For example: in one area, the number of children under one year old is estimated at 500. The activities reports show that 250 doses of BCG have been administered to children in this age group. The rate of vaccinal coverage for the BCG is therefore 50% (250/500 = 0.5);
Unfortunately, all nurses do not know the population figures for each age group. Sometimes they do not even know the overall figure for the population served by them. They would therefore find it useful to inquire into the results of national censuses in their area, and to organize the up-dating of the latter, when needed, with the help of local development committees or of volunteers.
— special investigations: protocols for vaccinal coverage surveys have been developed by WHO. They are simple and inexpensive. The investigators visit randomly selected homes and check the vaccination cards of 210 children divided into 30 groups of 7 children. The results provide a good indication of vaccinal coverage in the area in which the survey is done. This survey may be performed in combination with others dealing with the reasons for non-vaccination, the degree of use of primary health care services and the incidence of diarrhoea.

6.3. Disease surveillance

The main objective of an immunization programme is to decrease the number of cases of the target diseases, and thus the number of deaths and disabilities resulting from them.

Disease surveillance is a way of measuring the changes in mortality (number of deaths) and morbidity (number of cases) for a given disease. Surveillance is said to be "data collection in view of action", since the data, or findings, are used to determine the programme requirements, the main diseases and the most exposed population groups.

It is subsequently used to evaluate the impact of the programme; that is, to study the extent to which mortality and morbidity have been decreased, for the target diseases, by vaccination.

Disease surveillance is based on 3 main elements:

— recognition of diseases;
— the notification, collection and analysis of data;
— use of the conlusions.

6.3.1. Recognition of diseases

It is essential that every individual working within an immunization programme be capable of recognizing the 6 target diseases.

Here are some reminders of the clinical signs and complications linked with each of these diseases, all of which may be avoided by immunization.

• **Measles**

This is an acute, eruptive disease, extremely wide-spread, caused by a virus. Most children catch it at some time, between the ages of 5-6 months, when the protection transmitted by their mother disappears, and 5-6 years. Measles can only be caught once in a lifetime, since it provides permanent protection against another bout of the disease.

The first clinical signs occur after an 8 to 12-day incubation period.

Fever is the first sign, followed by red, tearing eyes, an abundantly running nose and a dry cough. The inside of the mouth and the throat are entirely red. The voice is hoarse. Close investigation of the inside of the cheeks, especially in front of the premolars, shows small red spots with a pin-sized white point in the centre: this is Koplick's sign, and is characteristic of measles. It occurs about 24 hours before the appearance of the eruption and disappears within 1 or 2 days. Diarrhoea then ensues, with frequent, slimy faeces.

The eruption occurs 3 to 4 days after the onset of the disease, first on the forehead and behind the ears, then on the entire face, and gradually spreads to the entire body. It takes the form of small red pimples, clearly felt by touching the skin. They disappear within a few days, the skin peals and is mealy-looking. The fever subsides, diarrhoea ceases within about one week, and the child recovers.

Measles may lead to complications, however, particularly in underprivileged surroundings. These are mainly pulmonary superinfection, severe dehydration due to diarrhoea and malnutrition, all possibly fatal. An estimated 2,500,000 children die of measles each year throughout the world.

Otitis, laryngitis and keratitis are less frequent complications. Encephalitis occurs in one case out of one thousand, causing death or permanent damage.

Contrary to popular belief, then, measles is neither valuable for a child's growth, nor harmless.

Measles is transmitted through the air (by the cough or saliva of a diseased child); it is highly contagious and very frequent. It is always present, with strong seasonal peaks and some serious epidemics. Only diseased individuals transmit the disease. Vaccination is the only effective protective measure.

Reminder of the most important points for diagnosing measles:

— fever 38 °C or over;
— cough, running nose, red eyes;
— eruption occurring after 3-4 days of fever, lasting 3 days or more;
— Koplick's sign: small red spots with a white point in the centre, on the inside of the cheeks;
— contact with a suspected case of measles during the previous 2 weeks, or an epidemic of measles in the area.

• **Pertussis** (whooping cough)

This is an acute, infectious disease characterized by fits of coughing. It affects children under 5 and is especially serious for those under one year old. No protection is transmitted from mother to child. It is caused by the Bordet-Gengou bacillus.

The disease appears after an incubation period of 2 to 12 days. At first the child coughs, has a running nose, tearing eyes and a slightly red throat.

At the end of two weeks the cough becomes characteristic. It occurs frequently, in bouts, especially at night. The cough is paroxysmal: the child coughs continually for at least 20 seconds, and cannot catch his/her breath. The face is congested, the eyes red, the child seems to be suffocating. He/she then inhales suddenly, making a characteristic whooping sound resembling the cock's crowing. The bouts of coughing are repeated, only ending when a sticky mucus is expelled. Often they lead to vomiting. The disease lasts 4 to 8 weeks. The coughing subsides and finally disappears, leaving the child exhausted from lack of sleep and repeated vomiting.

Possible complications are:

— asphyxiating paroxysms, especially in small children: they are often fatal;
— bronchopneumonia and encephalitis;
— undernourishment.

In infants the paroxysms are not clearcut, and the disease is difficult to diagnose.

The germ is eliminated in the particles expelled when the patient coughs (aerial transmission). Only patients can transmit the disease.

Vaccination is the only effective measure for the prevention of pertussis.

Reminder of the most important points for diagnosing pertussis:

— influenza-like period of one to 2 weeks;
— followed by intensive coughing, lasting 2 weeks or more;
— then, paroxystic coughing, often followed by characteristic inhaling (crowing);
— cough followed by vomiting;
— in infants: prolonged bouts of coughing often followed by a period of asphyxiation and/or arrested breathing;
— exposure to a suspected case during the previous 3 weeks.

- **Tetanus**

Tetanus is a toxinfection caused by a toxin secreted by the Nicolaier bacillus. The germ enters the body through a wound due to injury or a thorn. It proliferates there, and the toxin spreads to the entire body. It is the toxin which produces the signs of disease.

Tetanus takes two different forms, one in older children and adults, the other in newborn babies.

In older children and adults, the incubation period is variable, lasting from 4 to 21 days. Fever is moderate at the onset, increasing gradually to reach 40 or 41 °C. The first characteristic sign is inability to open the mouth, due to the contraction of the jaw muscles. The patient is unable to eat. Contraction then affects the muscles of the trunk, followed by those of the limbs. Noise and light set off generalized contractions, causing the patient to **stiffen completely**, "like a board", with only the head and heels resting on the bed. The muscles commanding breathing and swallowing are affected, making these functions difficult. In the absence of treatment these disorders grow worse, leading to death. Treatment is delicate and dear, and 1 patient out of 2 dies despite it.

Only vaccination provides protection, since even prior disease does not do so.

In neonates, tetanus takes on a very special form. The entrance site is the infant's navel, dirtied by the instrument used to cut the umbilical cord, or by the application of earth,

leaves or other substances traditionally used during home deliveries (cow dung, spiderweb, wasp's nest).

After birth, the child seems healthy and sucks well. After 5 to 7 days, his/her mouth is tightly closed and sucking is impossible. Fever occurs and rises gradually. Several days later, the child's body is entirely stiff and contracted, with the trunk and legs extended, arms bent and fists clenched, head thrust backward. Spasmodic contraction occurs, and 9 out of 10 babies die.

The only preventive measures are:

— vaccination of women against tetanus during pregnancy. This protects the baby at birth as well as the mother;
— the improvement of childbirth care, which would also avoid neonatal tetanus.

Reminder of the most important points for diagnosing neonatal tetanus:

— normal sucking and crying during the first 2 days of life, at least;
— signs of the disease occur between the 5th and 28th day: inability to suck, followed by stiffening and/or fits of generalized spasms;
— death in most cases.

- **Poliomyelitis**

Poliomyelitis is a viral infection caused by one of three types of poliomyelitis virus (1, 2, 3). Infection is usually benign, producing diarrhoea or influenza. It may go completely unnoticed. In some rare cases — 1 out of 100 — it is serious, causing muscular paralysis which may lead to fatal respiratory disorders or subsequent paralysis of the limbs, leaving the patient crippled for life.

Following a 1 to 2-week incubation period, the disease is marked by fever, headaches, general malaise. During the following 3 to 5 days the fever persists, the child still has headaches, stiffening occurs in the back of the neck, along with muscular pain or cramps. Paralysis occurs at the end of one week. It may affect one arm or leg or all limbs, or even the chest. This paralysis is characterized by the absence of reflexes, while superficial sensitivity remains normal.

Paralysis is permanent in those parts of the body which are affected, causing growth disorders and deformities, particularly when the disease occurs at an early age and does not receive treatment.

The infection affects almost all children under 5 years old. Each of the three types of poliovirus confers separate protection. The protection transmitted by the mother lasts 2 to 3 months.

Contamination is induced by infected individuals, either directly or indirectly, through water, since the virus is capable of surviving in water (water tanks, marigots) for long periods of time. Epidemics mostly occur when sanitation and living conditions are poor.

Vaccination is the only effective preventive measure available at present. It should be combined with improved sanitation.

Reminder of the most important points for diagnosing poliomyelitis:

— the child moves normally, is affected suddenly;
— weakness or paralysis of a leg or an arm (more rarely), often after a period of "influenza" or diarrhoea;

— paralysis ceases to progress after 3 days. Sensitivity is normal, paralysis is flaccid.

- **Tuberculosis**

This is a severe contagious disease, caused by a germ called the tubercle bacillus. The infection is often benign: the infected individual does not develop any clinical signs and recovers spontaneously, retaining only an allergy, attested by a positive reaction to the tuberculin skin tests. This is what is called a common primary infection.

Occasionally the infection is serious, and is characterized by the following signs, in infants: the child loses weight, cries constantly, is feverish. In an older child the signs are constant fatigue, loss of interest in play, headaches and a lasting cough.

In children, tuberculosis may take the form of:

— tuberculous meningitis;
— pulmonary miliary tuberculosis;
— cervical or axillary adenitis;
— osteitis or arthritis.

These forms are all serious, causing frequent sequelae and occasional death.

The BCG vaccine avoids these severe forms of tuberculosis in children.

In adults, the pulmonary form is prevalent. It should be suspected when the patient:

— has been coughing for more than 2 weeks;
— expectorates, especially when the sputa are blood-spotted;
— complains of pain in the chest;
— has lost weight;
— has lost his/her appetite.

The diagnosis is confirmed by the isolation of tubercle bacilli (t.b.) in the sputa. Treatment is absolutely necessary.

The disease is spread directly, by contact with a patient whose coughing contaminates those around him/her (aerial contamination). Objects soiled by the patient or milk products from tuberculous cows may also cause contamination (digestive contamination).

BCG vaccination is a part of tuberculosis control, along with the screening and treatment of the diseased. It is a means of preventing severe forms of tuberculosis in children.

Reminder of the most important points for diagnosing tuberculosis:

This is a chronic, evolutive disease. It is suspected when a child:

— has been in contact with a suspected or confirmed case of pulmonary tuberculosis;
— does not recover normally after a case of measles or pertussis;
— loses weight, coughs, has a whistling respiration and does not respond to treatment with antibiotics;
— has soft or firm, painless swelling of a group of superficial glands (particularly of the neck glands);
— develops skeletal or articular damage with a gradual onset;
— shows signs of meningitis or of any disease of the central nervous system;
— develops a hardened, painless mass on the abdomen and/or a mobile, liquid mass.

The probability of tuberculosis is great when there is also:

— an induration with a diameter of 10 mm or more following an intradermal tuberculin test;
— suggestive x-ray results (chest, bones, joints);
— a positive response to antituberculosis treatment.

Proof a disease requires the isolation of tubercle bacilli by microscopy or culture.

- **Diphtheria**

Diphtheria is a contagious disease induced by the Klebs-Loeffler bacillus, which develops in the rear of the throat and secretes a poison, or exotoxin, thanks to which the disease is spread to all of the organs.

Diphtheria is not very frequent and does not represent a major health problem.

It mostly strikes 2 to 6 year-olds. When it affects the tonsils, the disease begins by fever, a bloody nasal effusion and a painful sore throat. The child is tired and eats little. The neck is slightly swollen. At the end of 4 to 6 days the child is very tired, the swelling of the neck has worsened, the throat is covered with greyish membranes. The infection extends to the vocal cords (membranous croup, hoarseness) and often reaches the trachea, preventing the child from breathing. This causes fits of suffocation, possibly leading to asphyxiation and death.

The toxin may affect the heart of kidneys, or even cause paralysis.

Nasal diphtheria, on the other hand, is often less serious, and cutaneous diphtheria usually goes unnoticed. Both do contribute to the dissemination of the germ, however.

Contagion occurs directly, through contact with a patient, but also through healthy carriers.

Disease or infection confers immunity of varying duration.

Vaccination, on the other hand, provides lasting protection.

Reminder of the most important points for diagnosing diphtheria :

— pharyngitis, rhinopharyngitis or laryngitis with membranes, swollen neck glands;
— fatigue, malaise;
— hoarseness, respiration difficult (croup);
— in the most severe cases, heart and kidney disorders, paralysis.

6.3.2. The notification, collection and analysis of data

Once a case of disease is recognized, it must be notified. There are 3 types of notification:

— routine notification: the majority of health establishments make a report, on a monthly basis when possible, containing all basic information pertaining to cases of the target diseases.
Such a system is difficult to maintain on a regular basis, and its effectiveness is limited, since patients do not all attend health establishments. The reports are more or less reliable depending on whether the centre is more or less well attended. Improvement of these data requires that routine notification be completed by "sample" notification and special surveys.

The most valuable data on these diseases are the number of cases, number of deaths, age group affected and vaccinal status of the affected population group. An example of a monthly surveillance report from a health centre is reproduced below:

MONTHLY SURVEILLANCE REPORT

To be sent to the head physician of the province (address) before the 5th of the following month.

Health centre :
Region :

Year :
Month :

DISEASES	VACCINAL STATUS			TOTAL
	Vaccinated	Not vaccinated	Unknown	
Measles : • 0 - 8 months • 9 - 11 months • 12 - 23 months • 24 months or +				
Pertussis				
Neonatal tetanus				
Non-neonatal tetanus				

Sent by :
Date :

Received by :
Date :

— "Sample" notification: data is collected by notification units specially selected for their reliability, good will and ability to provide accurate reports at regular intervals;
— special surveys: these are particularly useful for added precision, as a complement to the data furnished by routine and sample notification, and for the collection of additional data, as in the case of an epidemic, for instance. Here is an example of the questions to be asked during a measles epidemic, and of the measures to be taken to avoid it.

Why did cases occur ?	How could they have been avoided ?
Unvaccinated	
• Under 9 months old	• Nothing can be done
• No contact with services	• Improve access
• Contact with the health team but vaccinal status not checked	• Check vaccinal status of all children seen
• Status checked but not vaccinated	• Vaccinate all children seen
Vaccinated	
• Before 9 months	• Vaccinate between 9 and 23 months
• During incubation	• Nothing can be done
• Few cases in vaccinated persons	• Nothing can be done
• Many cases in vaccinated persons	• Possible problem with vaccination. Investigation required

Once collected, data are analysed at the local level, then at the regional and national levels. Analysis may indicate a trend in disease and the effectiveness of the immunization programme, identify problems and difficulties, as well as epidemics. It should be followed by action; that is, correcting of errors, perfecting the programme, establishing future objectives for the reduction of morbidity and mortality, etc.

Data collected during surveillance should also be sent back to the grass root personnel by the high-level officials. This is **feed-back:** it stimulates the personnel and helps it to understand the results of its own efforts, as well as the difficulties and successes of the programme. It may take the form of a monthly bulletin, meetings, etc.

Other types of evaluation must also be done for the proper follow-up of an immunization programme: the effectiveness and quality of vaccines (assessed essentially by serological surveys and laboratory testing), evaluation of the cost of the programme, and of the effectiveness of the cold chain.

7. ACCELERATING THE PROGRAMMES

1990 is approaching, and vaccinal coverage around the world is progressing, but it is still far from ideal. The most important task at the present time is to increase vaccinal coverage for the target diseases in the EPI, and to achieve a lasting reduction in mortality and morbidity. An acceleration of these programmes means that a considerable effort must be made to attain these objectives.

Thorough examination of the experience now available has brought to light those points which must not be neglected if the acceleration of the programme is to be a success. Here are some examples.

Community participation

It is an indispensable part of any effort to accelerate the programme. Vaccinal coverage can only be increased with the active participation of the community in the following activities:

— helping with initial surveys;
— helping in the surveillance of the target diseases;
— contributing to the organization of vaccination sessions;
— helping to identify problems within the programme, as well as the health needs of the population;
— encouraging parents to bring their children for vaccination, etc.

This requires preliminary work in health education and social mobilization.

Political involvement

This is necessary at both a national and a regional level. The enthusiasm and support of politicians, cultural and religious leaders and other people who exert some influence on public opinion and the decision-making process are most important for the success of the programme.

Sometimes official involvement is visible to ordinary people: for example, special vaccination days may be launched by the President and broadcast on radio or television. Some political officials have been seen to administer the poliomyelitis vaccine themselves.

Cooperation between sectors

Various sectors must take part in the programme's activities, particularly when mass immunization campaigns are involved. For example, the Ministry of Health will need the help of the Ministry of Education, so that schoolchildren will be able to motivate their family, and for permission to use schools as gathering points for vaccination. The Ministries of Communication, Transportation and the Armed Forces will also have a role to play.

The participation of non-governmental international agencies, religious, cultural and community groups and various associations is also essential.

Spreading information

In an effort to accelerate a movement, the medias have an enormous impact. They may inform and motivate people with respect to vaccination. A variety of means may be used: the press, radio, television, the participation of artists and celebrities, music, posters, theatre, etc.

Satisfactory planning, supervision and training of personnel are basic to this acceleration.

WHO and FISE/UNICEF are working together in several countries in order to accelerate immunization programmes. Dozens of countries have already begun their programmes. Here are the two main approaches to acceleration.

7.1. Acceleration by the improvement of existing primary health care services

The effects of these efforts at acceleration will be felt in the long term. The aim is to reinforce health structures so as to ensure the ongoing performance of vaccination and of other primary health care services. This method is therefore based on the proper training of personnel, logistic support and adequate equipment, the reinforcement of health education and the increasingly massive participation of the community in the planning and implementation of activities. Schools are another place on which efforts may be concentrated: schoolchildren should be familiar with vaccination and make sure that their younger brothers and sisters are vaccinated.

WHO considers the following activities to be most important:

— the administration of vaccines and the furnishing of information about immunization to every family that brings a child to a health unit (hospital, health centre, clinic, etc.). In other words, this means that the vaccinal status of all children should be checked and immunization completed, regardless of malnutrition or minor diseases;
— the reduction of the drop-out rate for immunization (often children receive a first injection and do not return for the following ones). Parents should be well informed of the need for several doses; children who do not come back should be actively sought, with the help of the community. Village development committees as well as political, trade union and religious organizations, etc. may be encouraged to work at this;
— priority should be given to the fight against measles, poliomyelitis and neonatal tetanus;
— the improvement of immunization services in the densely populated peri-urban areas, to which a great many of the rural underprivileged have migrated.

7.2. Acceleration by national vaccination days

This involves mass vaccination of all target children in one country or region, against one or several diseases. The action may last one day, or continue for several days or weeks.

The first requirement for the implementation of a mass immunization campaign is a strong political will. It is not too difficult to mobilize governments on this theme, since such campaigns have politically favourable repercussions. FISE/UNICEF has been particularly active in this respect. It has succeeded in obtaining the engagement of governments, but also the mobilization of material resources, through donors. Thanks to their often spectacular results, mass campaigns are a most effective contribution to the success of this action.

The active participation of the community and its institutions is also required for a national vaccination day. This may be achieved with the help of volunteer workers, for instance. It is essential that a number of ministries and agencies — those touched by immunization — cooperate, while the managerial and financial support of international organizations must be obtained. The population should be mobilized by massive publicizing, using all possible means.

Special vaccination days may arouse considerable enthusiasm, which is highly beneficial for the ensuing immunization activities, and may even reinforce interest in other health activities.

Some efforts of this type have been spectacularly successful. They have rapidly improved vaccinal coverage in countries where no other type of action could achieve this. It must be clear, however, that the success of the operation depends on meticulous planning and organization of the logistics, personnel and publicizing.

Planning must make sure that the vaccine is available, that the volunteer workers are trained in their tasks and that the public is well informed about the programme, and encouraged to participate. Those countries which have provided particularly brilliant examples of successful vaccination days include Turkey, Burkina Faso, Salvador, Brazil and Colombia.

This type of activity does have some risks and disadvantages, however. Lack of proper planning may cause costs to rise, and this may necessitate the interruption of other health activities. Such days should only be arranged until the routine services are able to take the relay.

National vaccination days should be viewed as a catalytic, stimulating operation. In many situations they may be valuable as a starting point for a long-terme strategy in which immunization is integrated with other health services, particularly those dealing with mothers and children.

When national vaccination days are organized, their contribution to a long-terme strategy should be defined, and the measures taken to support these special days should be conceived in such a way as to reinforce the functioning of the existant health services.

8. CONCLUSION

Immunization is a very important action. When well done, it may avoid deaths and permanent damage. Each member of the health team is responsible, as an individual, for the effectiveness of each vaccination.

In almost all countries throughout the world, an enormous effort is presently being made to increase the vaccinal coverage of children. Governments, non-governmental agencies, WHO, FISE/UNICEF and others have clearly pledged themselves to this cause, which mobilizes several thousands of individuals and very considerable resources.

All this may seem too complicated for so simple an act as the vaccination of a child. Nonetheless, despite all of this mobilization and the major progress acheived thanks to the EPI, vaccinal coverage is still very low in most developing countries.

Vaccinal coverage in 12-month-old children in developing countries (1985, China excepted).

BCG	48%
DPT (3rd dose)	36%
Poliomyelitis (3rd dose)	36%
Measles	21%
Tetanus II (pregnant women)	17%

In Africa, vaccinal coverage is estimated at about 30% for the BCG, 15% for the DPT (3rd dose) and 30% for measles.

According to estimations, however, the EPI saved the lives of approximately one million children in 1985, and avoided incapacitating sequelae for hundreds of thousands of children. These results are gratifying and encouraging, and they motivate us to pursue the goal of making immunization available for all children, throughout the world, by 1990, with increased vigour.

The prospects for future progress are good. The basic structure for the continuation and acceleration of the EPI is already well established on the international level, as well as in most countries, while others are in the process of launching these programmes.

Over 30 million health workers have participated in training for the EPI at different levels. Tremendous financial resources are continually employed; they are furnished by agencies linked to the United Nations, national governments or private, volunteer foundations. Social and political mobilization in favour of immunization is on the rise.

Immunization programmes have been evaluated and investigated in more than 70 countries. The disease surveillance system is constantly being perfected. Great advances are being made in research: new, more efficient and more resistant vaccines are being developed; facilities for the cold chain are being perfected; new survey methods and new immunization strategies are being presented; immunization schedules are being simplified. Several countries have organized national vaccination days which have been extraordinarily successful. In addition, programmes are accelerated by the reinforcement of existing health structures.

Last, the EPI is continually expanding, while immunization is becoming integrated with other primary health care activities such as guidance for mothers with respect to maternal nutrition, breast-feeding, weaning, oral rehydration, the surveillance of growth, planned parenthood, the furnishing of essential drugs, etc.

Your work and your personal effort are a very important part of the attempt to amplify the positive impact of immunization and other primary health care measures on the quality of community life in the developing countries, and to achieve the final goals of universal immunization and good health for all.

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Module 3: How to give vaccines.
Module 4: Preparing for an immunization session.
Module 5: How to conduction an outreach immunization session.
Module 6: Health Education in an immunization programme.
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II. STORAGE AND STERILIZATION TECHNIQUES* THE SPECIFIC ROLE OF THE COLD CHAIN

1. REASONS FOR THE COLD CHAIN

In order to remain active, vaccines, must be maintained **continuously** within a specific temperature range (see table 1) from the moment they are produced until they are injected. This is the meaning of the cold chain.

If the cold chain is broken at any point the vaccines must be destroyed, since they have then lost all effectiveness.

In order to function properly, a cold chain requires the combined presence of **efficient, reliable equipment** and of **qualified, vigilant personnel** at all levels.

The cold chain is composed of the following elements:

— a **national storage** centre, near an international airport, with a one-year supply of vaccines for the entire target population;
— **regional storage** centres, with a three-month supply of vaccines for the entire population of the region;
— **peripheral immunization centres** scattered throughout the region, managing a supply for about one month;
— **clinics,** which either perform vaccination on the spot and/or supply mobile teams, depending on the strategy chose. They have a supply for about one week;
— **mobile teams,** with portable cold boxes, with an autonomy of several days.

This standardized model should not hide the fact that a great variety of situations exist with respect to the organization of the cold chain, due to specific local requirements (access to peripheral centres more or less difficult, etc.).

Those evaluations done up to present of the cold chain in the EPI have shown that national and regional depots function correctly, with very definite geographic variations (many problems in Africa, whereas the South-East Asian region shows a globally highly satisfactory situation). Proper functioning at these levels should not hide the fact that a single breakdown would affect enormous amounts of vaccine.

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More details on this group may be found in Appendix 1.

The main problems occur at the local levels, however, and more specifically with respect to transportation and the fuel and power supplies, as well as cold packs:

— few vehicles and little maintenance available;
— electricity distributed very irregularly, quality and availability of fuel quite variable, frequent shortage of funds for purchasing fuel and performing maintenance work;
— facilities often unable to satisfy the needs for cold packs. These deficiencies should be taken into account by national decision-makers and sponsors when setting up an EPI;
— the initial investment for the establishment of a cold chain, once spread over the lifetime of the facilities, only represents 30% of their total cost. The greater part of their cost — often borne by the country — is represented by maintenance (45%) and power (25%). New mechanisms and more reliable and economical new technologies (solar energy) must be developed, so that the heavy burden of financing the functioning of the cold chain will not be left to the individual countries;
— the EPI should be adjusted to each country's needs. Personnel must be trained in dimensioning facilities, maintenance of vehicles and of cold-producing equipment and surveillance of the overall functioning (medical personnel).

Table 1
Storage time and temperature

	Central Store	Transport to region	Regional store	Transport to district	Static unit	Mobil team
Yellow fever	8 months at − 20 °C	− 20 °C at + 8 °C	3 months at − 20 °C	− 20 °C at + 8 °C	1 month 0 at + 8 °C	1 week 0 at + 8 °C
Measles	2 years at − 20 °C	− 20 °C at + 8 °C	3 months at − 20 °C	− 20 °C at + 8 °C	1 month 0 at + 8 °C	
Polio (oral)	2 years at − 20 °C	− 20 °C at + 8 °C	3 months at − 20 °C	− 20 °C at + 8 °C	1 week 0 at + 8 °C	
BCG	8 months 0 at + 8 °C	0 at + 8 °C	3 months 0 at + 8 °C	0 at + 8 °C	1 month 0 at + 8 °C	
DPT	1,5 year 0 at + 8 °C	0 at + 8 °C	3 months 0 at + 8 °C	0 at + 8 °C	1 month 0 at + 8 °C	
Tetanus	1,5 year 0 at + 8 °C	0 at + 8 °C	3 months 0 at + 8 °C	0 at + 8 °C	1 month 0 at + 8 °C	

Source : UNICEF-WHO
Note: Never freeze DPT and tetanus vaccine.

2. MANAGEMENT OF VACCINE SUPPLIES

At the central level, the one-year supply of vaccines is generally stored in cold rooms. Personnel in charge of central storage is also responsible for transportation to and from these cold rooms:

- to them, from the airport. This requires coordination between the sender, the transporter, customs and the supply manager;
- from them, to the regional centres. Types of transportation vary from one country to another. They include refrigerated vehicles (delivery vans, lorries), mobile refrigerators placed inside vehicles, or even cold boxes. In the latter two cases, the proper functioning of the refrigerator, not necessarily conceived for this type of use, must be checked, and a sufficient production of ice planned for the cold boxes (example: 50 kg of ice and 5 cold boxes for providing a regional centre serving 500,000 inhabitants with a three-month supply).

Vaccines sensitive to freezing (DPT, tetanus) should **absolutely not** be placed near blocks of ice.

2.1. Regional storage

Regional centres usually deal with **3-month supplies of vaccines,** plus an additional 25% to avoid any shortage.

Transportation of the vaccines to the peripheral centres is usually done in cold boxes.

If 10 centres, each serving 50,000 inhabitants, are to be supplied each month, equipment capable of producing about 15 kg of ice every two days is required: this is the amount needed for supplying one peripheral centre. It is **imperative** in this case that the supplies be properly managed, with delivery to peripheral centres at regular intervals, so that there is no need to deliver supplies to three centres in two days, for example, since the ice production would then be insufficient and would endanger the cold chain.

2.2. Peripheral centres

The storage capacity of a centre serving 50,000 inhabitants and receiving **monthly** deliveries (and with a 25% reserve of vaccines) is as follows: one refrigerator with a 30-litre capacity and one 15-litre freezer.

According to the EPI strategy, the ice production should be sufficient to supply five clinics once a week (this requires a production of about 3-4 kg of ice a day) and/or to supply mobile vaccination teams (the amount of ice varies with the number of teams: 1-2 kg per day and per team). At this level, the size of the equipment is essentially determined by the requirements for ice production.

2.3. The clinic

A clinic serving 10,000 inhabitants and receiving a supply of vaccines weekly requires little storage space (less than 5 l). Here too, however, the need to produce ice for mobile

teams (1 to 2 kg per day and per team) or for on-the-spot vaccination determines the type of equipment needed. A typical refrigerator (1) would have a storage capacity of 12 litres.

At the clinic and peripheral centre levels, vaccination teams also need to sterilize the injection material.

We will now discuss the facilities needed to run a cold chain satisfactorily.

3. THE FACILITIES AND THEIR USE

Once the space required for storing vaccines is determined (see above), the facilities required at each level may be evaluated. The information essential to the choice must be considered **in each case.** The main criteria involved are presented here, with the understanding that the decision as to size should always be made by a specialist.

The central depot should always be specially arranged (2):

- amounts of vaccine requiring storage: there is a threshold, which must be determined case by case, depending upon the local cost of labour, beyond which it is economically preferable to build cold rooms rather than to buy refrigerators or freezers;
- facilities are always run on the public electricity network, and the adjunction of an independent power-generating unit is absolutely necessary, as an alternative source in case of a power failure;
- when specially constructed for this purpose, buildings should be based on bioclimatic architectural concepts in order to control the internal temperature in hot countries (by ventilation, thermal insulation of roof, orientation of windows and doors) (see fig. a);
- a device for the surveillance of temperature and an alarm system must be installed.

Often other facilities using similar technology exist in the same city: this facilitates maintenance.

3.1. Regional depots and peripheral centres

3.1.1. Choosing refrigerators and freezers

The overall approach to the selection of a freezer or a refrigerator may be summarized by the following synoptic table (published by WHO).

a) How much vaccine must be stored at + 4 °C and at − 20 °C ?
→ **Vaccine storage capacity**

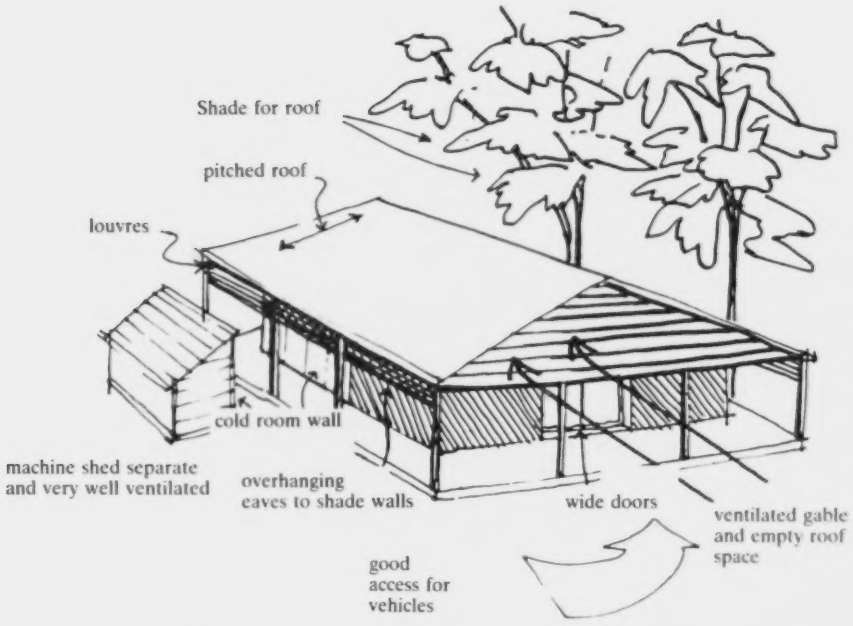
b) How much ice or icepacks should be frozen per 24 hours ?
→ **Icemaking performance**

c) What external temperatures are reached? Not more than + 32 °C ? High day time

(1) Taken from the WHO/UNICEF catalogue.
(2) WHO document EPI/CCIS/80.15.

Figure A

Features of a vaccine store building



Source: WHO. Guidelines for establishing national and regional vaccine stores. Geneva: WHO, 1980. EPI/CCIS/80.15. Rev. 1.

and low night time temperatures ? Continuous temperatures between + 32 °C and + 43 °C ?
→ **Refrigerator performance**

d) Which power sources are available ? Electricity: what voltage; what frequency? continuous or not continuous supply? Kerosene or bottled gas? What is the local cost of power?
→ **Power source**

e) What cold life is needed if power source fails? How many hours will vaccine remain under + 10 °C? Is there a standby power source?
→ **Cold life**

f) Repair facilities and spare parts available for which types?
→ **Reliability**

g) Which refrigerator meets requirements a, b, c, d, e and f for lowest cost?
→ **Price**

The importance of taking all of these criteria into account when choosing facilities can never be overemphasized. The first two points depend on the needs of the immunization programme, while the next three are determined by local conditions **only.** Good knowledge of these is therefore necessary.

Despite the existence of a wide range of refrigerators and freezers appropriate for the EPI (see the catalogue published by WHO, which lists the tested and approved equipment for cold chains) the accumulation of compelling conditions actually limits the final choice considerably, as a rule.

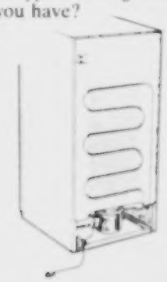
The following types of refrigerators and freezers are available:

— **compressor** refrigerators and freezers, powered exclusively by electricity;
— **absorption** refrigerators and freezers run on gas or kerosene with electricity as a possible complementary source of power, but an inefficient one (see fig. b);

Figure B

What type of refrigerator do you have?

Compression and absorption types of refrigerators

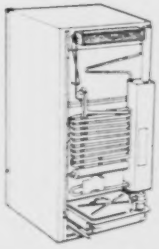


Compression

- This is always powered by electricity and hums when it is working.

Notice

- The thin condenser pipes.
- The cylindrical compressor at the bottom.



Absorption

- This may be powered by electricity gas or kerosene and is silent when it is working.

Notice

- The fat pipes of the cooling unit.
- The burner. Gas or kerosene only.
- The fuel tank. Kerosene only.
- The rectangular chimney.

Source: Manage the cold chain system: training for mid-level managers. Geneva/ WHO, 1985. EPI/ MLM: CC/Rev. 2. February 1985.

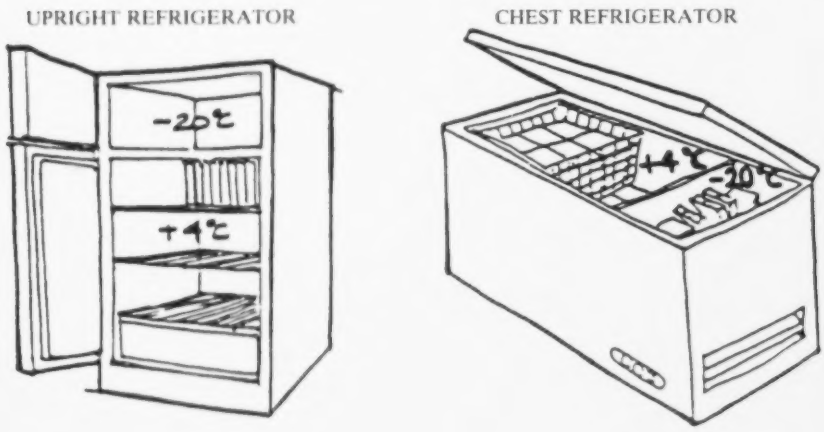
— solar refrigerators, which free users of the problems involved in kerosene and electricity supply systems. They are based either on absorption or on compression. The numerous defects of kerosene — run refrigerators (rapid choking up, frequent changing of the wick, difficulty in maintaining an even temperature in the appliance, frequent readjustment required, quality of kerosene highly variable, cost of kerosene, etc.) and the advances in solar technology have incited WHO and UNICEF to test many models in laboratories and in the field. Eight photovoltaic refrigerators or freezers (1), functioning either by compression or by absorption, are approved by WHO (along with 38 other, conventional aplicances). This equipment is more reliable than kerosene or gas-run appliances, but on the other hand the initial investment is much greater. Over 200 solar refrigerators are now installed or being installed around the world (Zaire, Peru, Panama) for the total or partial coverage of the needs of immunization programmes.

Table 2 summarizes the criteria governing the choice of a refrigerator/freezer.

The different appliances exist in 2 versions: "upright" or "chest". It should be remembered that their space coefficients are not the same, and that more cold air is lost when an "upright" type appliance is opened than in the case of a "chest".

Figure C

Different types of refrigerators



(1) The photovoltaic effect: the energy of light is transformed into electricity by solar batteries. During the day, the electricity produced runs the refrigerator directly, and charges batteries. At night electricity is provided by the batteries only. In addition to running cold-producing systems, a photovoltaic installation may furnish lighting (scialytic or other) for a health centre.

Refrigerators may withstand interruptions in the power supply (between 4 and 10 hours, depending on the model, when room temperature is 32 °C), but freezers are generally far more sensitive to interruptions. This characteristic is only known for the equipment tested by WHO.

The energy consumption of these appliances varies considerably with the temperature of the room in which they are placed.

Table 2
Criteria for choosing a refrigerator/freezer

Type of appliance	Appropriate conditions	Reliability	Energy consumption* for an appliance** in a room at 32/43 °C	Price* 1985 $	Remarks
Compression (electricity furnished by power line)	Reliable electric supply system (not a power generating unit functioning several hours each day.	Excellent	Réfrigérator 40 l + freezer 1.95/2.92 kwh/day Freezer 96 l 1.9/3.5 kwh/day	380 160	
Absorption - kerosene - gas - kerosene/ electricity - gas/electricity	No reliable or permanent electric supply system. Kerosene: generally available everywhere, with possible periods of shortage. Gas: some countries have an elaborate network for the distribution of bottled gas.	Relatively good (for gas) to mediocre, occasionally poor for kerosene	Refrigérator 68 l + freezer 30 l Kerosene : 0.7 l/day Gas : 0.6 kg/day Freezer 142 l. Kerosene : 2.5 l Gas : 1.5 kg/day	458 725	Frequent changing of wick or burner (kerosene model). Much maintenance. Functioning costly.
Photovoltaic solar appliance	No reliable electric supply system. No regular supply of gas or kerosene.	Good	Réfrigérator 90 l*** + freezer 33 l 0.98 kw/day Freezer 16 l 1.04 kwh/day	6,000 9,000	Little maintenance. Requires the presence of a specialist for breakdowns. Remember to include the cost of battery renewal (every 5-7 years).

* Taken from the WHO/UNICEF catalogue: The cold chain - Product Information Sheets.
** Vaccine storage capacity (no. of litres).
*** The largest approved model at present. The cost of these appliances depends on the amount of sunlight on the site.

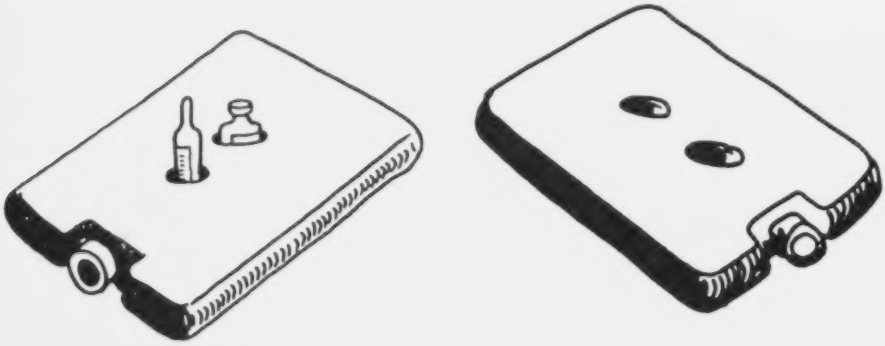
3.1.2. Choosing cold boxes

The important role of **cold boxes,** used by the mobile teams at the peripheral levels of the cold chain, should be emphasized:

— a capacity of approximately one litre is quite sufficient to cover the needs of a mobile team for several days;
— the choice of a cold box depends on the duration of the team's tours, which must be accurately known. Different models retain cold for varying amounts of time (from 10 to 150 hours!), and the number of cold packs follows suit (see table 3);
— cold packs should be arranged with great care in the cold box so as to obtain a uniform temperature and the greatest possible conservation period (see fig. d);

Figure D

Special icepacks to cool vaccine vials

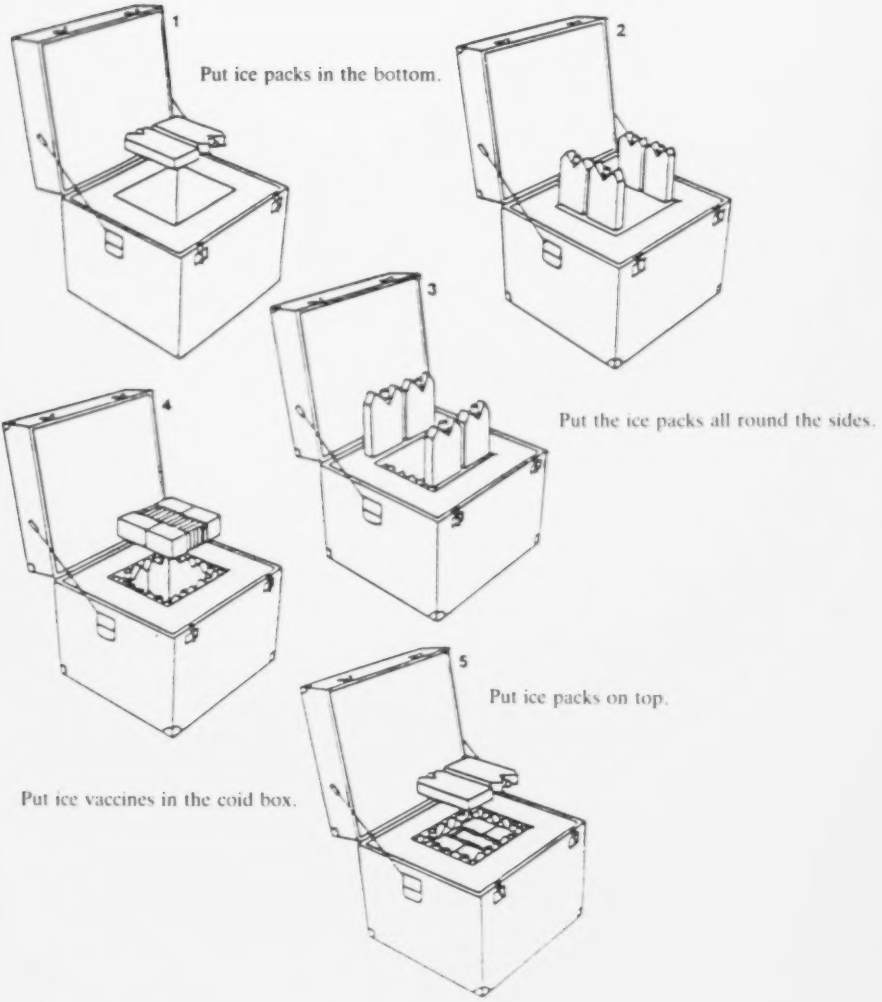


Source: Manage the cold chain system: training for mid-level managers. Geneva/ WHO, 1985. EPI/ MLM: CC/Rev. 2. February 1985.

— the lid should be replaced as quickly as possible;
— it is preferable to carry along an extra cold pack (or loose ice) on which to place vaccines during the vaccination session (see fig. e). This avoids the need to open the cold box continually.

Figure E

How to pack a cold box



Source: Manage the cold chain system: training for mid-level managers. Geneva/ WHO, 1985. EPI/ MLM: CC/Rev. 2. February 1985.

Table 3
Characteristics of different cold boxes
(Taken from the WHO catalogue)

	Vaccine storage capacity (litres)					
	0.3	1.7	3	6.8	10	31
Cold life in hours at + 32 °C ambient temperature	14	63	89	98	167	157
Number of cold packs	4	4	8	19	24	19
Weight of ice (kg)	1	1.6	2	7.6	9.6	4.75
Price (1985) (in $ per unit)	14	16	110	185	140	230

3.1.3. Sterilizers

In peripheral health centres where vaccination is performed and/or which send out mobile teams, the material used for injections is sterilized or disinfected.

Medical workers usually disinfect syringes and needles by boiling them for 30 minutes in a fish kettle. This does not eliminates the most resistant germs which may be present on needles and even possibly in syringes (hepatitis B or tetanus).

In order to avoid the temptation to shorten this lengthy boiling time, WHO has encouraged the development of pressure cookers (1) for sterilization. These eliminate all germs by maintaining them at 121 °C for 20 min. (see fig. f). At the same time, reusable plastic syringes which resist numerous sterilizations have been developed.

These cookers have a low capacity (several litres and 50 to 100 syringes) and are easily transported on a bicycle or motor bike.

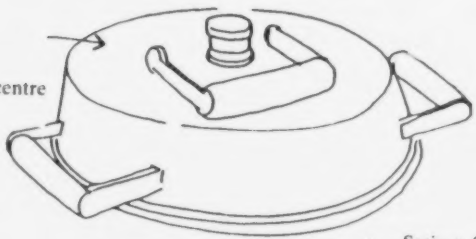
Although the choice of the basic equipment which constitutes a cold chain and of the material for sterilization is delicate, it should not overshadow the fact that the human environment is essential to its proper functioning. Serious, frequent maintenance, constant surveillance of the state of vaccines and of the functioning of equipment are essential.

(1) Pressure cooker: water vapour, created in a closed space using an external source of heat (kerosene, gas, charcoal or solar electricity) causes the pressure and temperature to rise - no higher than 121 °C - in these cookers. Sterilization should last 20 minutes once the pressure has been created.

Figure F

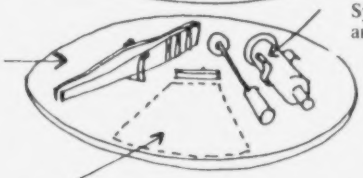
Pressure-cooker sterilizer (WHO)
(+ 121 °C/20 minutes)

LID
With steam escape valve in centre

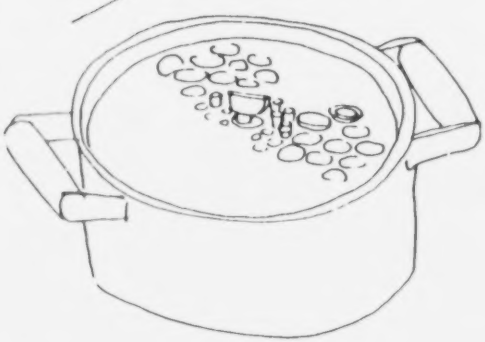


Syringe for stirring and tongs

INNER LID
with a system for attaching the syringe, the piston and the needle during transportation. Instructions on the upper side of the inner lid.



SYRINGE HOLDER
keeps the body of the syringe, the pistons and the needles from touching. (35 to 45 per holder).



BASE
deep enough to contain one syringe holder in one version, and two syringe holders in another version.

Source: WHO.

4. MONITORING THE COLD CHAIN

There are many devices for minitoring the functioning of the cold chain:

— indicators (or monitor cards), which accompany the vaccines from the central depot to the peripheral centres (at least one card per batch sent to the peripheral centres)

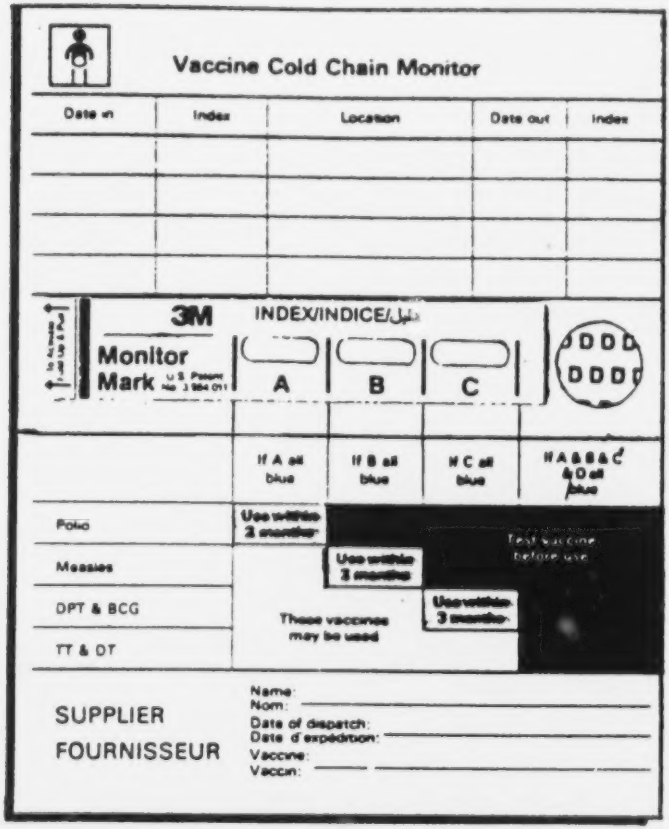
show any excesses in temperature and their duration. Vaccinators are thus able to judge the state of the vaccine (see fig. g);

— devices such as thermometers show the present temperature, independently of the "history" of the vaccine (see paragraph 4.2.).

4.1. The vaccine cold chain monitor

Figure G

The vaccine cold chain monitor



Source: WHO. Vaccine cold chain monitor. Geneva: WHO, 1985. EPI/CCIS/85.1. Rev. 2.

Windows A, B, C and D are activated (turn blue) when:

	Vaccines exposed to a temperature of	Number of days
Window A	+ 12 °C + 21 °C	3 days 2 days
Window B	+ 12 °C + 21 °C	8 days 4 days
Window C	+ 12 °C + 21 °C	14 days 11 days
Window D	+ 34 °C	2 hours

When window D only is activated, the cold chain has only been broken for 2 hours. The vaccines may be used normally.

The type of window activated determines the measures to be taken:

A, B, C and D: all white	All vaccines may be used.
A only blue	Use the polio vaccine within 3 months. No problem for the other vaccines.
A and B blue	Discard the polio vaccine and use the measles vaccine within 3 months.
A, B and C blue	Discard the polio and measles vaccines. Use DPT and BCG within 3 months.
A, B, C and D blue	Discard all vaccines.

At each point on the cold chain, it is important that the state of the vaccine monitor be noted upon arrival of the vaccines, by a responsible person. The weak points in the cold chain may thus be identified.

4.2. Instant monitoring

At the same time, some devices are available for checking individual elements of the cold chain from time to time:

- freezer alarm (for DPT, DT or tetanus vaccines);
- freeze indicators, attached to each cold pack, provide a warning in case there is a risk of freezing of the DPT, DT or tetanus vaccines;
- liquid crystal thermometers, to be placed in refrigerators. They show 2 °C graduations, between 0 and 20 °C.

At all points on the cold chain, a thermometer should be placed inside the facilities; it may be more or less sophisticated (with recording device, dial or liquid crystal).

The check-card should be filled out twice a day: in the morning and the afternoon (see fig. h). This card should be placed inside all cold chain equipment: it provides information on any break, and helps the medical personnel to make decisions.

Figure H

Refrigerator temperature and maintenance check sheet
Must be posted on the door of each refrigerator

Month _____ Year _____

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Date																																
Morning temperature																																
Afternoon temperature																																
Defrosting																																
KEROSENE REFRIGERATOR	Reservoir filled																															
	Burner cleaned																															
	Flue cleaned																															
	Wick trimmed																															

Person in charge _____

5. TRAINING PARTICIPANTS IN THE COLD CHAIN

Evaluations have shown the existence of gaps in the programmes implemented, both in the facilities constituting the cold chain and in their maintenance.

Who has developed a training strategy aimed at people on all levels:

— international consultants, decision-makers involved in programming the EPI and dimensioning their facilities.
— technicians in charge of maintenance. Sessions have been organized on this point in countries which are setting up an EPI: special tool kits, tool kits for repairing each type of refrigerator/freezer have been developed and are usually distributed to trained personnel;
— medical personnel, in order to increase their awareness of the specificity of the cold chain.

In the same spirit, WHO publishes many teaching aids on "the logistics of the cold chain in primary health care", technical manuals on how the equipment functions, its breakdowns and how to repair them, and its maintenance.

Last, many technical reports are available, showing the state of advancement of research with respect to the cold chain.

N.B.: the tasks listed below constitute an excellent means of preventing breakdowns. For more details and for repair techniques, consult the "Manual for use" and "Manual for refrigeration" published by WHO.

MAINTENANCE OF COLD-PRODUCING EQUIPMENT
OPERATIONS REQUIRED FOR ALL TYPES OF APPLIANCES

Installation: Leave a space of at least 30 cm between the appliance and the wall (below and behind it).

Maintenance/Surveillance:

— clean the condenser and the refrigeration unit using a **soft brush** to remove dust and dirt;
— make sure the door is airtight, and if necessary clean the gasket and apply talcum powder;
— **defrosting:** check the ice that forms on the evaporator **once a week.** If it is more than 6-10 mm thick, defrost the appliance:
- transfer the vaccines to an ice-filled cold box;
- stop the refrigerator;
- remove the ice, using your hands. **Never use a sharp instrument;**
- empty the tray, dry the freezer compartment;
- start the refrigerator and return vaccines to it when the temperature reaches + 4 °C.

— check the inside temperature every morning **and** afternoon.

SPECIAL OPERATIONS

Compression refrigerator
(electric)

Make sure the voltage is appropriate.

Absorption refrigerator
(gas, kerosene and/or electricity)

Once a month, and whenever necessary:
— clean the flue whenever the flame smokes;
— make sure there is no leak at the joints of gas pipes;

Once a year:
— clean the burner and its injector nozzle;
— clean the flue;
— check the thermostat (gas).

SPECIFIC TASKS FOR KEROSENE-RUN REFRIGERATORS/FREEZERS

Once a day:

— check the size and colour of the flame. If it smokes, lower in a bit. If it continues to smoke, clean the wick, the burner and the flue;
— fill the reservoir with **clean** kerosene. Always use a funnel with a filter or a clean cloth.

Once a week:

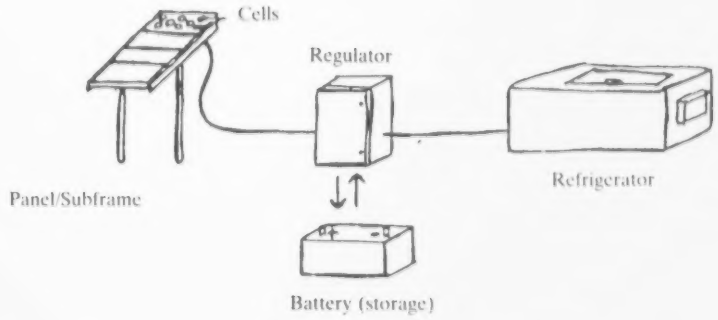
— make sure the kerosene in the reservoir is clean. If necessary, clean the reservoir;
— cut the wick (carefully remove the burnt part, using scissors or a razor blade). Leave no more than 2 mm protruding;
— make sure the refrigerator is level.

PHOTOVOLTAIC REFRIGERATORS

The refrigeration or freezing capacity of the appliances presently available ranges from a maximum of 120 litres to a minimum of 16 litres. They are therefore mostly appropriate for peripheral centres and clinics. These appliances are optimized (reinforced thermal insulation, direct current) so as to decrease the number of solar panels required (these are very expensive). The total cost of this equipment ranges from 3,500 to 10,000 dollars (1985) depending on the volume refrigerated and the site (the amount of sunlight partially determines the number of solar panels).

Figure 1

Diagram



APPENDIX 1

THE GRET/GERES RENEWABLE ENERGIES UNIT*

The main activities of the GRET/GERES unit are as follows:

— technical support for field projects in rural Third World areas, based on the theme of renewable energy resources;
— training of technical cooperation workers and volunteers in governmental agencies called upon to work on these themes in Third World countries;
— enhancement of this field work by the production of written or audiovisual documents (cards, dossiers, diaporamas);
— research and experiments on appropriate technology for the rural areas of the Third World, in close collaboration with other governmental agencies or French or foreign research centres doing field work;
— impulsing this network of French competencies on the theme "Renewable energy resources and the Third World";
— various services with respect to renewable energy resources, such as an answering service.

The GRET/GERES unit is developing a specific, dynamic approach to **health,** aimed at reducing the technical and economic burden of energy on the health structures. Its action on this **Energy-Health** interface takes the following forms:

— research, in collaboration with the COSTIC and in liaison with WHO, to analyse the characteristics of the cold chain for the storage of vaccines and medicine in developing countries;
— analysis of needs with respect to sterilization of surgical instruments. This has led a firm to commercialize photovoltaïc sterilizers appropriate for use in clinics, and for developing countries;
— implementation of surveys on the needs for equipment, the place of energy at the various levels in the health pyramid in Mali and Senegal. The aim was to provide technical and economic data for the better satisfaction of vital needs, and to help decision-makers in this field. Local medical personnel contribute greatly to this process;
— evaluation of programmes for equipping 850 clinics in Zaïre, using solar energy (including 100 clinics equipped with refrigerators specially conceived for the developing countries) and of the San hospital (Mali).

In addition to these activities initiated by the unit, the GERES also develops specific action on lighting, which is an excellent complement to this Health work.

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* GRET: Groupe de Recherches et d'Echanges Technologiques - 213, rue Lafayette - 75010 Paris - FRANCE. Tél.: 42.39.13.14.

GERES: Groupe Energies Renouvelables - 73, avenue Corot - 13013 Marseille - FRANCE. Tél.: 91.70.92.93.

If you have any questions concerning the use of renewable energies, or if the information furnished in this journal is insufficient, do not hesitate to write to us, giving as clear as possible a description of your project's environment. If, on the other hand, you have personal experience with an experiment or an achievement in the field of renewable energies in a Third World country, we are very eager to hear about it, so that other people in similar situations may take advantage of your successes... or your failures.

Thank you in advance.

The GRET/GERES team

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ANNOUNCEMENT

The Johns Hopkins University. Population Information Program. In: Population Reports. Series L, 1986, N° 5, March/April.

Immunizing the world's children

Immunization against the most common and deadly childhood diseases saves the lives of some one million children in developing countries each year. But more than 3.5 million others are killed or disabled by diseases that immunization could have prevented. Fewer than half of one-year-olds have been immunized against the major preventable diseases. Concerted efforts are now underway to expand immunization services to all the world's infants and pregnant women by 1990.

The World Health Organization (WHO) Expanded Program on Immunization (EPI) focuses on six diseases:

- **Measles** affects nearly all unimmunized children and kills over two million children annually.
- **Pertussis** (whooping cough) kills some 600,000 children each year and affects millions more.
- **Neonatal tetanus,** contracted through contamination of the umbilical cord at birth, kills at least 800,000 each year.
- **Polio** is the major cause of lameness in the developing world and each year kills about 30,000.
- **Tuberculosis,** which each year attacks 10 million, can be especially severe in young children.
- **Diphtheria** is less common but kills 10 to 15 percent of its victims.

Immunization against these diseases is safe and effective. Decades of experience in developed countries and a variety of evidence from Africa, Asia, and Latin America show that sickness and death from these diseases fall sharply where immunization is widely available.

The challenge is to deliver the basic vaccines to all infants and tetanus toxoid to all pregnant women. Programs have been able to immunize an infant fully for as little as $5-$15 (US), but many programs reach less than half of the population at risk.

Most programs start by offering immunizations at fixed health posts. Outreach and mobile services that set up temporary vaccination points in the community are often needed as well. Also, intensive campagns have immunized many children quickly. For example, special vaccination days, widely publicized by mass media and even dor-to-door visits, have proved effective in such varied countries as Brazil, Burkina Faso, Columbia, Ecuador, and Turkey. Whether such campaigns encourage the development of long-term, continuing immunization services is much debated. Even without campaigns, persuasive communication efforts are necessary.

A major logistical problem is keeping vaccines cold to protect their potency. Careless handling, a broken refrigerator, or electrical failure can break the cold chain and leave children unprotected.

Comprehensive evaluations show that immunization programs face common problems. The chief weaknesses are limited surveillance of disease cases and immunization coverage, inadequate supervision, and insufficient communication efforts. Nonetheless, many programs have expanded coverage greatly in the last decade. In some countries sickness and death rates have dropped sharply. Like family planning and other basic health measures, immunization programs can succeed when there is planning, commitment, skill, and persistence at every level.

This issue (38 pages) contains 652 records.

NOTICE

The following back issues of "Children in the Tropics" are still available :

107 Food-nutrition-health and development.
108-109 Primary health care.
110 Family health and birth control.
111 Poliomyelitis.
112 Sex education in traditional life in black Africa.
113 Reflections on a strategy for education for health.
114 Vaccination: organization, technique and evaluation.
115 Proposals for improving the quality of water.
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